FVTX Detector

FVTX Transition to Operations

[Street Address] [City], [State] [Postal Code]
Phone: [Your Phone] Fax: [Your Fax] E-Mail: mbrooks@lanl.gov

Optimal Performance Goals

FVTX Functional Requirements

The functional requirements from our Management Plan are shown in

Table 1, along with the current state of the deliverables. The goals of the Management Plan are for the most part the same as our "optimal performance goals" with the exception of the Mini strips active and Hit efficiency. For the mini-strips active, our goal would be to have >90% of the detector active so that we could retain high track finding efficiency. We are close to achieving that goal already and expect to be able to fully achieve the goal after the 2012 shutdown when we can repair our two non-working ROCs, and want to notch out a support structure member so that we can get two data fibers plugged in that currently have interference with the support structure.. **Effort needed to repair/replace the non-working ROCs includes some assembly repair work (probably few $k M&S costs) and physicist and technician effort to disassemble and reassemble the big wheel areas that are affected. Effort needed to notch out the support structure will be provided by BNL technicians.**

The hit efficiency that we have attained is already also very close to our optimal performance goal of ~98% efficiency. When we measure the efficiency in a region of the detector that is known to be fully functional, we achieve approximately this efficiency. We believe any lower efficiencies obtained are in regions where we have known hardware issues, but will continue to analyze this in more detail with larger data sets.

Table 1 PHENIX FVTX System Functional Requirements.

Requirement	Proposed Deliverable	Achieved Deliverable
Mini strips active	>80%	99%, 90%*
Hit efficiency	>85%	>95%
Radiation length per wedge	< 2.4 %	<2.4%
Detector hit resolution	< 25 μm	25 μm
Random noise hits/chip	<0.1%	~0.02%
Level-1 latency	4 μs	4 μs
Level-1 Multi-Event buffer depth	4 events	4 events
Read-out time	< 40 μs	9 μs
Read-out rate	> 10 kHz	>27 kHz

*99.9% of wedge channels work, 90% can be read out through the full readout chain

**27 kHz can be sustained with maximum number of channels firing. Ordinarily a much higher rate can in principle be sustained.

Alignment and Geometry

In order to obtain our optimal performance goals for DCA measurements, it is critical that we have our detector aligned. To do this, we need to incorporate all survey information about our detector into the software and extract final alignment corrections by analyzing straight tracks. We have already begun the process of processing survey data and incorporating it into our offline software.

An example of how the residuals improve with our first-pass at implementing wedge survey corrections can be seen in Figure 1 where the station 2 residuals versus phi are shown for the North arm before survey corrections (top) and after survey corrections (bottom). In addition to these survey measurements we need to incorporate the surveys of our disks in the cages and our cages in the PHENIX Hall. We also need to align our detector to other PHENIX detector subsystems, especially the VTX and the Muon Arms. We will do this with a combination of survey data and straight-through tracks as we are doing for the FVTX detector itself. We expect to complete the work of implementing survey information in the short term (by Spring 2012) and will be working on the extraction of refined alignment constants using straight tracks with the data collected in 2012. **The work to extract alignment corrections from real data will be carried out by physicists in the group and we expect to be able to implement these alignment corrections by the summer of 2012** as we already have software in place to extract alignment constants from real data, and it has proven to work with simulated data sets.

For data analyses, it is also important that our simulated geometry and materials accurately reflect the as-built detector. We expect ongoing effort to go into our GEANT simulation package to make sure that it provides an accurate reflection of our detector. **This work will be carried out by physicists in the group, headed up by Hubert van Hecke.**

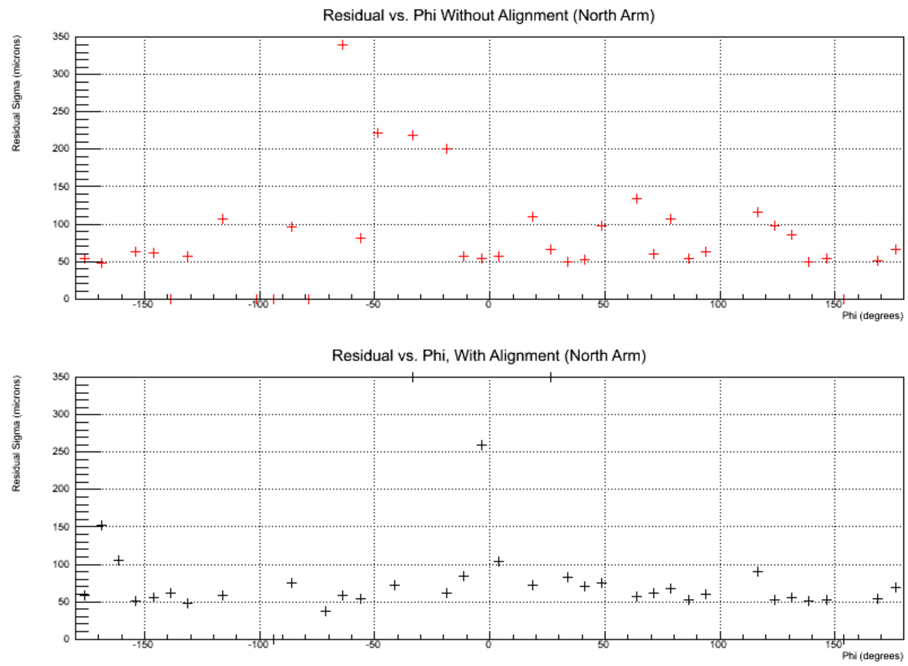


Figure 1 Station 2 residuals from station 1-2-3 tracks, versus phi, for the North arm, without any survey corrections (top plot) and with our first-pass survey corrections implemented (bottom plot). As can be seen, the overall residual distribution is improved with this set of survey corrections.

FVTX Offline Reconstruction

All the pieces of our offline reconstruction software are nominally in place but we expect significant physicist effort to go into refining this software and extracting the optimal performance from real data. Some of the pieces of offline software include: cluster finding and fitting, track finding and fitting, matching of tracks to the muon system, DCA calculations. We will aim to have the work of tuning up software by analyzing Run 12 data completed by the beginning of Run 13. **Several FTEs of physicist effort are expected across several FVTX institutions to complete this work.**

Combining FVTX with VTX

In order to obtain our optimal performance goals for DCA measurements, it is critical that we have event vertex information from the VTX (and possibly include the FVTX in vertex finding), and that we use VTX pixel hit points whenever a track crosses both the VTX and FVTX detector systems. The VTX group is actively working on the extraction of event vertices with the VTX using Run 11 data and we expect them to be able to translate this to Run 12 data once the algorithm refinement is completed. Given the low number of tracks in p-p events, we would like to add the FVTX information to the VTX information to recreate event vertices. Since we do not currently have a vertex-finding module for the FVTX we expect it to take a few months of effort to incorporate this. **Members of the LANL team (and perhaps other collaborators) will expect to work on this task and we hope to have initial work completed by the summer of 2012.**

Our track finding software already has the capability to include VTX hits in our track finding, but it needs to be refined to work well with real data and with the current VTX configuration. **Columbia University has been working on this task and we expect to complete the initial pass on track finding software refinement by the summer of 2012.**

Combining FVTX with the Muon Detectors

FVTX and Muon Tracker tracks need to be accurately matched to carry out our physics program. We have already established with real p-p data that the MuTr→FVTX tracks can be matched to within a few cms, as seen in Figure 2, which is approximately the expected resolution of the Muon System. Further work is needed to align the two detector systems and perform higher level analyses on these matched tracks to make sure our detector is performing at the optimal level. **We expect various physicists within the FVTX collaboration to carry out this work and hopefully optimize the performance by the beginning of Run 13.**

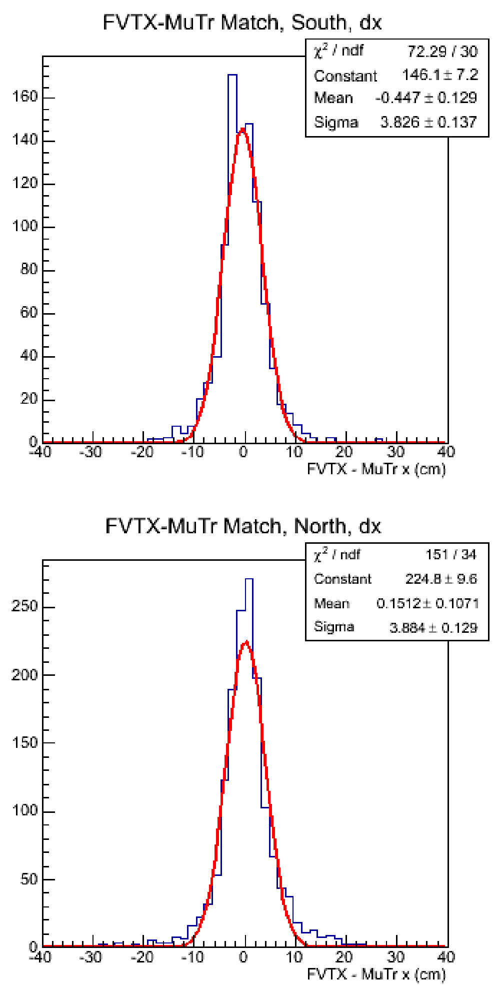


Figure 2 Muon tracks from a p-p data set are projected to the FVTX detector system station 3 are selected and a search for candidate matching tracks in the FVTX detector is performed. The distance between the muon track and any potential FVTX track is calculated and plotted for the South Arm (top) and the North Arm (bottom), dx distance (left) and dy distance (right).

Detector Readout Performance

Although our wedges, ROCS and FEMs are working at a high level already during this run, we have found during our commissioning that certain parts of the system are more prone to temporary readout failure during otherwise normal operations. These include:

(1) we have problems at times getting our START signal (which synchronizes the FEM and wedge clock counters) to operate 100% of the time on some ROCs. We suspect either the cable that is delivering the START or the grounding configuration between the ROC and clock distribution boards needs to be more robust. We have been investigating what affects this performance during the run and expect to implement some changes to the START distribution system during the next shutdown based upon the results of our studies. **The effort needed to address this will include some physicist time, perhaps some designer time if the clock distribution boards are to be modified, and some modest M&S costs. Work would be completed by the end of the 2012 shutdown.**

(2) During a given run there may be a wedge here and there which does not output data. We have not yet determined the cause of this but since the wedge has been proven to be fully operational, we suspect that some refinement in our FPGA software may be needed to ensure that all wedges participate in readout at all times. **The effort needed to address this would be physicist time from physicists who are familiar with the readout and with ones who are capable of tuning FPGA software. Work would be expected to be completed by the end of the 2012 shutdown.**

(3) We may want to add some cable pigtails to the ROCs to make it easier to perform cable hookup of ROCs in the IR. Currently the wedge power distribution cables and bias cables need to be plugged into the ROCs by reaching into a small area with little line-of-sight to the connectors of interest. With pigtails, the cable connection to cables in the IR could be made outside of the big wheel area. If we

are to add these pigtails, **we would have M&S costs for the cable parts and technician time to assemble the cable pigtails**.

(4) We have measureable radiation damage to the sensors from the 2012 Run. The damage has not affected the performance of the detector, but we may want to investigate whether neutron shielding of the detector might reduce the dose that is received over the lifetime of the detector. **Physicist time is required to simulate the effects of shielding and to determine whether a proposal should be put forth to PHENIX. Some M&S and technician time costs may be incurred to implement shielding if a proposal is accepted.**

(5) To reduce leakage currents, it would also be desirable to operate our disks at a somewhat reduced temperature. **Some engineering/designer effort will be needed to determine what changes to the cooling system might be feasible to reduce our temperatures. Some M&S costs may be incurred to modify the cooling system to implement changes.**

Component Deliverables

The proposed and achieved component deliverables for the FVTX project are shown in Table 2. We have come to appreciate as we go through development of codes and commissioning that we would like to have more spare modules in some areas than we initially planned. This is partially because we like to retain a ROC/FEM/FEM_IB in a few test stands at various institutions which makes them unavailable for swapping if the real detector has a breakdown, and partially because we have had some board breakage during commissioning, especially of ROCs. For that reason, we plan to order both ROCs and FEMs above and beyond our proposed working spares. **Most of these costs are expected to be covered by** our remaining contingency, but any additional costs will be picked up by Operations.

Table 2 Component Deliverables of FVTX.

Item	Number Proposed	Number Delivered	Working Spares Proposed	Working Spares Delivered
Wedge assemblies				
Large Sensors	288	288	25 in spare wedges	25
Small Sensors	96	96	8 in spare wedges	10
Large Wedges	288	288	25	25
Small Wedges	96	96	8	10
ROC boards	24	24	4	4
FEM boards	48	48	6	4
Mechanical				
Large ½ Disks	12	12	2	2
Small ½ Disks	4	4	1	1
Suspension system	1 (VTX funded)	1	0	0
Dry gas enclosure	1 (VTX funded)	1	0	0
Cooling system	1 (VTX funded)	1	0	0
Power supply system	1	1	Spare	

			components available	
DCM channels	48	48	4	8

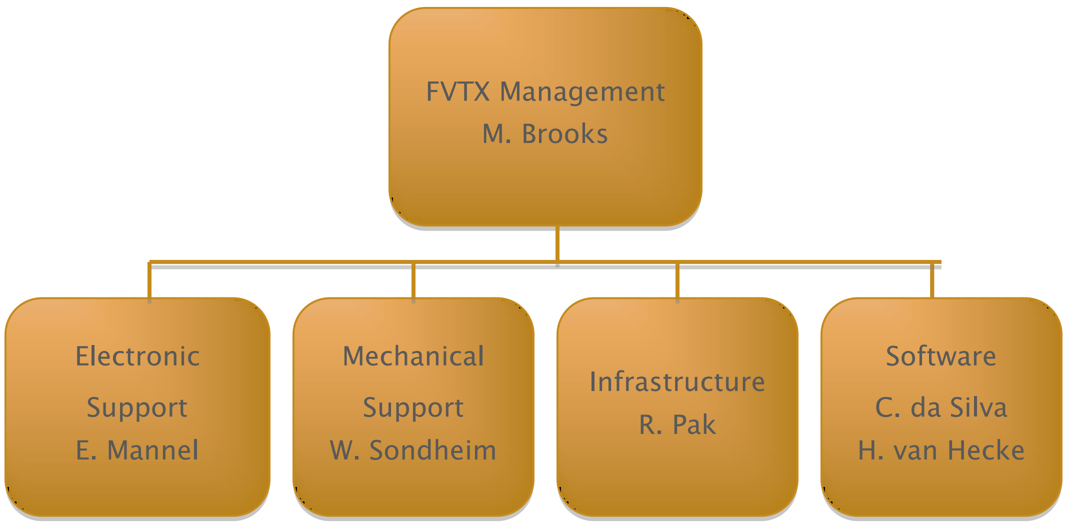
Steady-State Operations

Once the FVTX detector is in stead-state operation (hopefully we will achieve this after the Run 12 shutdown), we require staff to maintain the detector from year to year. Some of the activities during this period include:

- FVTX expert shifts will need to be filled continuously during each RHIC Run. FVTX physicists will fill this role.
- Coordinate the maintenance and operation of the FVTX detector each run – We can assume that during each shutdown there will be some minor repair work required for the FVTX such as replacing faulty boards, faulty cables, etc.
- Investigate, diagnose, and fix system integration issues that arise during commissioning and operations.
- Maintain the silicon wedge modules.
- Maintain the readout electronics.
- Maintain the LV and HV power distribution systems.
- Maintain the FVTX slow controls systems.
- Maintain and upgrade as needed the FVTX DAQ software, especially the FPGA code that resides in the ROCs, FEMs and FEM_IBs.
- Maintain the cooling system and infrastructure at BNL.
- Maintain the online monitoring software.

- Maintain the databases that contains detector logging information and calibration information.
- Continue to develop and maintain offline software.

Organization



Manpower and Budget

All engineering and technical effort on the FVTX is captured in the labor tables. The tables also reflect contributions by scientists and postdocs working specifically on FVTX Maintenance and Operations. Table 3 lists the institutions that will be contributing to the FVTX detector operations and maintenance periods, along with their major areas of responsibility.

Institution	Operation and Maintenance Responsibility
Brookhaven National Laboratory	Infrastructure E, S, H & Q Cooling system Power Distribution, Interlock support Integration support On site support
Los Alamos National Laboratory	FEE Power Distribution support Software support Mechanical Engineering On site support
New Mexico State University	Detector assembly maintenance support Software support On site support
University of New Mexico	Silicon sensors, HDIs, extension cables, assembly Software support On site support
Columbia University	Wedge Assembly Software support On site support
Nevis, University of Colorado	DCM maintenance

Table 3 FVTX Institutional responsibilities for maintenance and support of the FVTX Detector.

Available resources

The following tables give the resources that each institution expects to provide for FVTX maintenance and responsibilities during FY12 and for FY13 and beyond. Overall, in FY12 we had 13.35 FTEs of physicists, post-docs, engineers and technicians and 5 FTEs of graduate students supporting FVTX maintenance and operations. For FY2013 and beyond, we plan to have 10.6 FTEs of physicists, post-docs, engineers, and technicians supporting the maintenance and operation of FVTX. In addition 4.85 FTEs of graduate students will be working on a combination of M&O and research tasks associated with the FVTX.

FY2012

Brookhaven National Laboratory M&O FTEs 2012:

Person	FY12 FTE	Task
S. Boose	0.2	LV/HV Infrastructure
P. Giannotti	0.2	E,S,H&Q
J. Haggerty	0.2	HV/LV, DAQ, onsite support
M. Lenz	0.3	Wedges, infrastructure
D. Lynch	0.2	Infrastructure, onsite support
E. Mannel	0.5	FVTX electronics management
R. Pak	0.3	Infrastructure, E,S,H&Q, cooling & onsite support

R. Pisani	0.2	LV, HV, cooling
M. Purschke	0.2	HV, DAQ, onsite support
F. Toldo	0.2	LV, HV, onsite support
J. Tradeski	0.2	Cooling
Total	2.7	

BNL FVTX Operations Budget 2012

Item	Fully Burdened Funds
General M&S	$50,000
Spare Parts	$20,000
Engineering/Tech Support	$20,000
Travel	$2,000
Total	$92,000

Los Alamos National Laboratory M&O FTEs 2012:

Person	FY12 FTE	Task
Melynda Brooks (staff)	0.6	Management/Technical/Analysis Software
Hubert van Hecke (staff)	0.9	Management/Technical/Analysis Software
Pat McGaughey (staff)	0.5	Technical

Ming Liu (staff)	0.35	Technical/Analysis Software
Walt Sondheim (staff)	0.2	Technical
Jon Kapustinsky (staff)	0.1	Management/Technical
Xiaodong Jiang (staff)	0.2	Technical
Christine Aidala (PD, staff)	0.4	Technical/Analysis Software
Cesar da Silva (PD)	0.5	Technical/Analysis Software
Matt Durham (PD)	0.5	Technical/Analysis Software
Jin Huang (PD)	0.5	Technical/Analysis Software
Kwangbok Lee (PD)	0.5	Technical/Analysis Software
Engineering/Tech support (FEE)	0.1	
Total	5.35	

LANL FVTX Operations Budget 2012:

Item	Fully Burdened Funds
General M&S	$0
Engineering/Tech Support	$50,000
Travel	$50,000
Total	$100,000

University of New Mexico M&O FTEs 2012:

Person	FY12 FTE	Task
Douglas Fields	0.2	Management
Amaresh Datta (postdoc)	1.0	Technical/Analysis Software
Sergey Butsyk (postdoc)	0.5	Technical/Analysis Software
Aaron Key (PhD student)	1.0	Technical/Analysis Software
Kathy DeBlasio (PhD student)	0.15	Detector maintenance
Dillon Thomas (PhD student)	0.3	Detector maintenance
Total	3.15	

University of New Mexico FVTX Operations Budget 2012:

Item	Fully Burdened Funds
General M&S	$4,000
Travel	$12,000
Total	$16,000

New Mexico State University M&O FTEs 2012:

Person	FY12 FTE	Task
Stephen Pate (Prof)	0.25	Management/Technical
Vassili Papavassiliou (Prof)	0.25	Management/Technical
Xiaorong Wang (PD)	1.0	Simulation/Analysis Software
Feng Wei (PD)	1.0	Technical/Analysis Software
Elaine Tennant (PhD student)	1.0	Analysis
Abraham Meles (PhD student)	1.0	Technical/Analysis Software
Darshana Perera (PhD student)	0.75	Technical/Analysis Software
New grad student	0.25	Technical/Analysis Software
Total	5.5	

New Mexico State University FVTX Operations Budget 2012:

Item	Fully Burdened Funds
General M&S	$0
Travel	$18,000
Total	$18,000

Columbia University M&O FTEs 2012:

Person	FY12 FTE	Task
Beau Meredith (PD)	0.5	Technical/Analysis Software
Aaron Veicht (PhD student)	0.5	Technical/Analysis Software

Nevis M&O FTEs 2012:

Person	FY12 FTE	Task
Chen-Yi Chi	0.10	DCM II
Technician	0.15	DCM II
Total	0.35	

University of Colorado M&O FTEs 2012:

Person	FY12 FTE	Task
Michael McCumber (PD)	0.25	DCM II Readout
Jamie Nagle (Prof)	<0.05	DCM II
Total	0.25	

FY2013 and Beyond

Brookhaven National Laboratory M&O FTEs 2013 and beyond

Person	FY13 FTE	Task
S. Boose	0.2	LV/HV Infrastructure
P. Giannotti	0.2	E,S,H&Q
J. Haggerty	0.2	HV/LV, DAQ, onsite support
M. Lenz	0.3	Wedges, infrastructure
D. Lynch	0.2	Infrastructure, onsite support
E. Mannel	0.5	FVTX electronics management
R. Pak	0.3	Infrastructure, E,S,H&Q, cooling & onsite support
R. Pisani	0.2	LV, HV, cooling
M. Purschke	0.2	HV, DAQ, onsite support
F. Toldo	0.2	LV, HV, onsite support
J. Tradeski	0.2	Cooling
Total	2.7	

BNL FVTX Operations Budget 2013

Item	Fully Burdened Funds
General M&S	$50,000
Spare Parts	$20,000
Engineering/Tech Support	$20,000
Travel	$2,000
Total	$92,000

Los Alamos National Laboratory M&O FTEs 2013 and beyond:

Person	FY13 FTE	Task
Melynda Brooks (staff)	0.4	Management/Technical/Analysis Software
Hubert van Hecke (staff)	0.4	Management/Technical/Analysis Software
Pat McGaughey (staff)	0.2	Technical
Ming Liu (staff)	0.3	Technical/Analysis Software
Walt Sondheim (staff)	0.2	Technical
Xiaodong Jiang (staff)	0.2	Technical
New PD	0.3	Technical/Analysis Software
Cesar da Silva (PD)	0.3	Technical/Analysis Software
Matt Durham (PD)	0.3	Technical/Analysis Software

Jin Huang (PD)	0.3	Technical/Analysis Software
Kwangbok Lee (PD)	0.3	Technical/Analysis Software
Engineering/Tech support	0.1	Technical/Analysis Software
Total	3.3	

LANL FVTX Operations Budget 2013:

Item	Fully Burdened Funds
General M&S	$5,000
Engineering/Tech Support	$70,000
Travel	$50,000
Total	$125,000

University of New Mexico M&O FTEs 2013 and beyond:

Person	FY13 FTE	Task
Douglas Fields	0.2	Management
Amaresh Datta (postdoc)	1.0	Technical/Analysis Software
Sergey Butsyk (postdoc)	0.5	Technical/Analysis Software
Aaron Key (PhD student)	1.0	Technical/Analysis Software
Kathy DeBlasio (PhD student)	0.3	Technical/Analysis Software

Dillon Thomas (PhD student)	0.3	Detector maintenance
Total	3.3	

University of New Mexico FVTX Operations Budget 2013:

Item	Fully Burdened Funds
General M&S	$4,000
Travel	$15,000
Total	$19,000

New Mexico State University M&O FTEs 2013 and beyond:

Person	FY13 FTE	Task
Stephen Pate (Prof)	0.25	Management/Technical
Vassili Papavassiliou (Prof)	0.25	Management/Technical
Xiaorong Wang (PD)	1.0	Simulation/Analysis Software

Feng Wei (PD)	1.0	Technical/Analysis Software
Abraham Meles (PhD student)	1.0	Technical/Analysis Software
Darshana Perera (PhD student)	1.0	Technical/Analysis Software
New grad student	0.25	Technical/Analysis Software
Total	4.75	

New Mexico State University FVTX Operations Budget 2013:

Item	Fully Burdened Funds
General M&S	$0
Travel	$18,000
Total	$18,000

Columbia University M&O FTEs 2013 and beyond:

Person	FY13 FTE	Task
Beau Meredith (PD)	0.2	Technical/Analysis Software
Aaron Veicht (PhD student)	1.0	Technical/Analysis Software

Nevis M&O FTEs 2013 and beyond:

Person	FY13 FTE	Task
Chen-Yi Chi	0.05	DCM II
Technician	0.05	DCM II
Total	0.1	

University of Colorado M&O FTEs 2013 and beyond:

Person	FY13 FTE	Task
Michael McCumber (PD)	0.05	DCM II
Jamie Nagle (Prof)	<0.05	DCM II
Total	0.05	