Risk-Based R&D Plan
for the
Neutron Electric Dipole Moment Project
(nEDM)

Project MIE #71RE

at
Los Alamos National Laboratory
Los Alamos, New Mexico
managed by
Los Alamos National Security, LLC

For the U.S. Department of Energy
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EDM Risk-Based R&D Plan Description

On October 4-7, 2006, the EDM collaboration met in Los Alamos to 1) review our design for cost savings, 2) update our risk processes and contingency evaluation in a workshop known as Fast Start II, 3) evaluate our R&D plan, 4) debate a new assembly plan and set of CD-4 requirements, 5) and have scientific discussions related to the EDM experiment.

This evaluation of the R&D plan consisted of short presentation on each subproject that was evaluated by the contract project manager (CPM) and an advisory committee, which consisted of Steve Lamoreaux (Yale), Bob Golub (NCSU), Geoff Greene (ORNL), Mike Hayden (Simon-Fraser), and Jan Boissevain (contractor to Caltech). The risks and action items in the risk tables are the synthesis of the opinions of the CPM and the advisory committee.

The risk evaluation Tables 1-3 are shown on the next page. These tables are <u>not</u> the same as those used for the project risk assessment. Rather, they are those connected to whether the EDM experiment is likely to make the proposed measurement with the proposed sensitivity. Hence, they are much more stringent and require that close to optimal performance be obtained from each crucial measurement. The priorities for the subprojects are relative to the overall risk, i.e. highest to lowest follows from red to green. The CPM is tracking the highest risk elements the most carefully but considers only the laser fluorescence and the slow controls as optional.

The following page contains a summary Gantt chart of the EDM R&D plan. Most tasks have adequate schedule contingency built in to provide confidence that they will be completed in the allocated time. The exceptions are the 0.3-K high voltage studies and the 3He injection test. They both require the completion of a new cryostat and must share that piece of apparatus. These two elements will be pressed to finish by the end of calendar year 2007. The Gantt chart starts at the beginning of fiscal year 2007. The tasks with the most (least) risk are shown in red (green), and the medium risk tasks are in black. The two costs shown in red are opportunities for a small amount ($90k) of new funding in FY'07.

The remaining 12 tables are the body of the plan and describe the goals, risks and appropriate actions by the CPM toward the WBS elements (1.1…) in the R&D project file. The color scheme of green, yellow and red follows Tables 1-3. Funding source, costs and completion dates are also shown. The lead institution is underlined.

The total cost for the R&D is $887k. This cost has the following funding sources: DOE construction ($300k), DOE operations ($40k – KB04 grant to NCSU), LDRD ($457k), and the opportunities for new funding, e.g. from the NSF ($90k). Only $300k is part of the TPC.

The goals of the research may or may not be met by every piece of equipment. Some parameter may even exceed the optimal specifications. Failure to match the optimal specifications should not be used to judge the success or failure of the R&D. At the CD-2 review, the collaboration will put forward a new evaluation of the sensitivity of the proposed apparatus to measure the neutron EDM. The decision to go forward should be based on the overall projected sensitivity derived from the EDM R&D.

The date of this plan is November 1, 2007. The CPM is working to implement the recommendations of his advisory committee. Hence, priorities and funding may still move from one subproject to another. New personnel are likely to be added as the collaboration continues to recruit new members.

The overall conclusion drawn by the CPM is that the R&D plan and schedule are aggressive. The collaboration will need to work well to successfully complete their assignments in the allotted time.

Risk Likelihood	
Very Likely	>90%
Likely	>50% and <90%
Unlikely	<50%

Table 1 – Risk likelihood extracted from Fast Start II presentation

	Marginal	Significant	Critical
Cost Impact on project contingency is:	<$25K	$25-$100K	>$100K
Schedule Impact on project schedule is:	All else	Level 1 or 2 Milestones	Impacts project completion date
Technical Impact on project performance is:	Optimal specification will be within 20%	Minimal specification will be bettered by 80%	Minimal specification may not be met

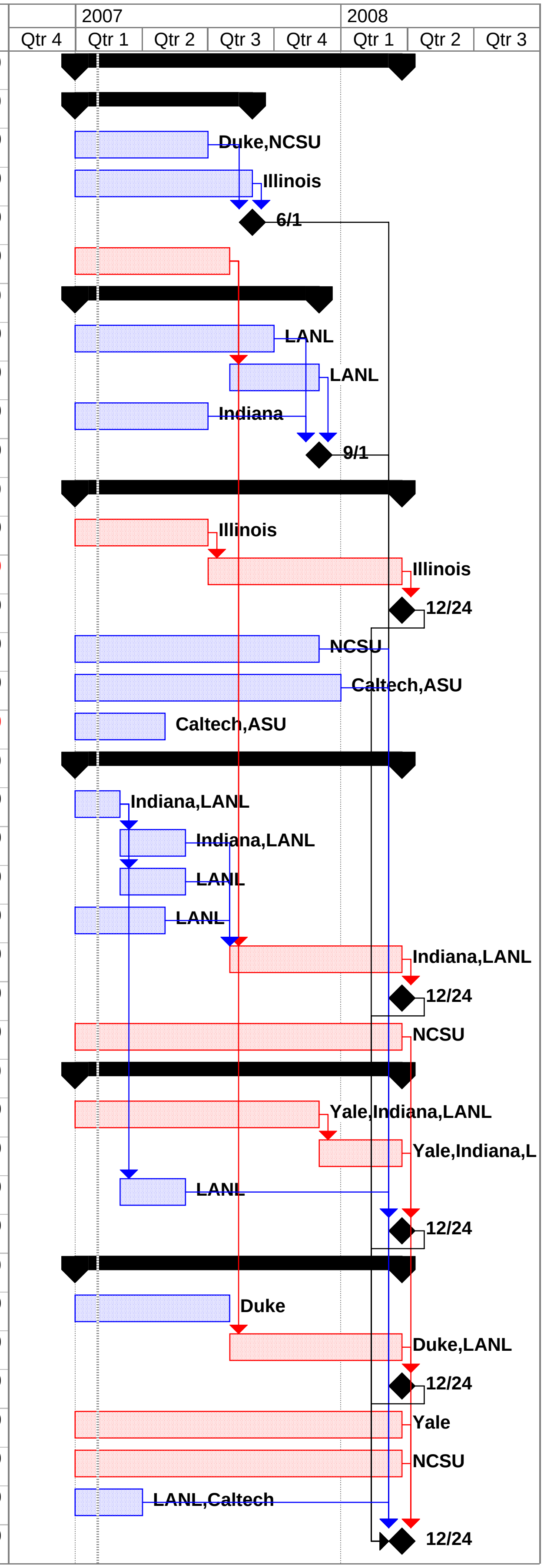
Table 2 – Risk impact as correlated to change control

Overall Risk Rating			
Likelihood of Occurrence	Impact/Consequence		
	Marginal	Significant	Critical
Very Likely	Medium	High	High
Likely	Low	Medium	High
Unlikely	Low	Low	Medium

Table 3 – Overall Risk

EDM Research and Development Plan

ID	WBS	Task Name	Total Cost
1	**1.1.2**	**EDM R&D through 2007**	**$887,000**
2	**1.1.2.1**	**3He relaxation time**	**$20,000**
3	-	dTPB	$0
4	-	Valve materials and dTPB	$0
5	-	3He relaxation measured	$0
6	**-**	**Construction of new cryostat**	$0
7	**1.1.2.2**	**Light collection**	**$72,000**
8	-	Room temperature mockup	$0
9	-	Electric field dependence	$0
10	-	4 K PMT	$0
11	-	Light studies complete	$0
12	**1.1.2.3**	**Valve Development**	**$105,000**
13	-	Bucket dewar tests	$40,000
14	-	Prototype valve	$65,000
15	-	Prototype valve working	$0
16	**1.1.2.4**	**Geometric phase**	$40,000
17	**1.1.2.5**	**Magnet Development**	$80,000
18	**-**	**3He holding coil construction**	$25,000
19	**1.1.2.6**	**High voltage studies**	**$140,000**
20	-	Complete 1.8 K studies	$0
21	-	Leakage currents	$0
22	-	SQUIDs near HV	$0
23	-	Select electrode material	$0
24	-	0.3 K studies	$0
25	-	HV studies complete	$0
26	**1.1.2.7**	**4He evaporative purification**	$100,000
27	**1.1.2.8**	**SQUID NMR signal**	**$125,000**
28	-	Development	$0
29	-	Test with 3He	$0
30	-	Test around HV	$0
31	-	SQUIDs developed	$0
32	**1.1.2.9**	**3He injection**	**$60,000**
33	-	Prepare equipment	$0
34	-	Measure injection properties	$0
35	-	3He injection tested	$0
36	**1.1.2.10**	**Laser induced fluorescence**	$50,000
37	**1.1.2.11**	**Slow Controls**	$50,000
38	**1.1.1.2**	**Neutron storage time**	$20,000
39	**-**	**EDM R&D Complete**	$0



WBS	1.1.2.1	Title	3He relaxation time
Funding Source	DOE Constr.	Institutions	Duke, Illinois
Funding Avail.	$20k	Opportunity	

Goal (Completion Dates): The overall goal is to measure the 3He relaxation time from 0.3-0.6 K to insure that the neutrons and 3He remain polarized throughout the measurement cycle. At 30,000 sec, there is essentially no impact on the sensitivity. Any value greater than the neutron storage time provides a small degradation to the sensitivity. At Duke, the result for a cell coated with dTPB is a subsidiary measurement to the geometric phase measurement. (4/1/07). At Illinois, the measurement is to be made on materials used in the valves and transfer lines as well as dTPB (6/1/07)

Risk Descriptions: Obtaining a value >1000 sec at 0.5K is crucial to having a small impact on the EDM sensitivity. No measurements have been made at the operating temperature. The advisory committee judged this quantity to be the major scientific unknown in the design.

Risk	Likelihood	Impact	Overall Risk	
Technical	Likely	Critical	High	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support both efforts at Duke and Illinois. The measurement on dTPB is difficult and important enough to warrant duplicate effort. The measurement on materials to be used in the valves is important.

Goal (Completion Dates):

Risk Descriptions:

Risk	Likelihood	Impact	Overall Risk	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.2.2	Title	Light collection
Funding Source	LDRD	Institutions	LANL, Indiana
Funding Avail.	$72k	Opportunity	

Goal (Completion Dates): Measure the mean number of photoelectrons (PE) from a room temperature mockup of the geometry of the cell and light guides. The light is produced from scintillations produced by an alpha particle source in argon doped with xenon. The quantitative connection to a cryogenic system has been made by the neutron lifetime group. Twenty PE is sufficient, but 40 would be better for the particle ID. (7/1/06).

Risk Descriptions: The mean number of photoelectrons from a neutron capture on 3He is influences the effectiveness of the particle ID. The lifetime experiment achieved a mean number of PE of 12 with a room temperature PMT. A better geometry may not be available though there are ideas.

Risk	Likelihood	Impact	Overall Risk	
Technical	Likely	Critical	High	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the room-temperature light guide tests.

Goal (Completion Dates): Measure the dependence of the light output in the scintillating LHe as a function of applied electric field strength. Little to no effect is expected. The measurement will consist of putting an alpha source a short distance from a light guide in LHe. The field applied to the LHe can be varied. (9/1/07)

Risk Descriptions: George Seidel of the CD-1 review panel suggested that there might be an effect. The effect might produce a better signal or more after-pulses. A test to make sure there is no surprise bad effect is warranted.

Risk	Likelihood	Impact	Overall Risk	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the cryogenic high-voltage tests tests.

WBS		**Title**	Light collection continued	
Funding Source		**Institutions**		
Funding Avail.		**Opportunity**		

Goal (Completion Dates): Measure the light output of a PMT at 4-6 K. A PMT will be cooled to LHe temperatures in a vacuum container. Its quantum efficiency will be measured as a function of temperature. If the tube operates at these temperatures without more than 25% degradation, several gaps in the light guides can be eliminated to yield about a 70% gain in the photon statistics. (4/1/07)

Risk Descriptions: Tubes like these have run at 27 K in LNe. The operation at about 4 K is to be expected but has never been tried. The major task besides the measurement is to prevent room temperature He from ruining the tubes.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Marginal	Low	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the cryogenic tube operation tests.

Goal (Completion Dates):

Risk Descriptions:

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.2.3	**Title**	Valve development
Funding Source	DOE Constr.	**Institutions**	Illinois
Funding Avail.	$40k	**Opportunity**	$65k

Goal (Completion Dates): Test a variety of materials for reliable seals in a bucket dewar. The valve stem and seat will be made of materials believed to be friendly to 3He polarization. They will be used in an existing commercial valve. Check the quality of seal after many cycles at a variety of pressures (in case pressurization for the HV is needed). The goal would be to achieve an adequate seal after thousands of cycles. (4/1/07)

Risk Descriptions: The reliability and performance of the valves is a program imperative. The valves control the state of the system. The recent success at Harvard with a similar valve is encouraging.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Likely	Critical	High	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the Illinois R&D. Get other institutions like MIT to join the R&D effort.

Goal (Completion Dates): Build a first-article EDM valve and test the reliability of the seal and the performance of the actuator as a function of pressure after thousands of cycles. An additional small cryostat is necessary for this test. (12/24/07)

Risk Descriptions: The engineers claim that if the materials pass the bucket-dewar test, this test is highly likely to succeed and give it less priority. However, having a working valve in hand would be reassuring.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Marginal	Low	
Cost	Likely	Significant	Medium	

CPM Actions: Support the full valve test if the bucket-dewar test goes well. There is an opportunity for the CPM to seek some additional funding to help this measurement.

WBS	1.1.2.4	**Title**	Geometric Phase	
Funding Source	DOE Operations	**Institutions**	NCSU	
Funding Avail.	~$40k	**Opportunity**		

Goal (Completion Dates): The goal is to check our theory of the geometric phase effect on 3He. A large gradient field will be applied to the polarized 3He to measure their change in precession rate. The results should be compatible with the diffusive (as opposed to the ballistic) velocity governing the effect. Measuring the temperature dependence is crucial input to establishing the operating temperature of the experiment. (9/1/07)

Risk Descriptions: The CD-1 reviewers underestimated the importance of this measurement. If our theoretic understanding were incorrect, the experimental method would be in jeopardy. At the starting point, the collaboration believes its theory to be correct.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Even though the measurement is being carried out at Duke, encourage the NCSU team to carry it out with a minimal involvement by Duke personnel.

Goal (Completion Dates):

Risk Descriptions:

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.2.5	**Title**	Magnet development
Funding Source	DOE Constr.	**Institutions**	Caltech, Arizona
Funding Avail.	$80k	**Opportunity**	$25k

Goal (Completion Dates): Build a ½-scale constant field magnet to learn the construction techniques needed to obtain 10^{-5}/cm uniformity needed to suppress the geometric phase effect. This uniformity is state of the art. In the process, assess the need for the ferromagnetic shield. (10/1/07)

Risk Descriptions: All the calculations show the uniformity is achievable. It is necessary to demonstrate it can be done.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the Caltech-Arizona effort. Make sure the magnet criteria being evaluated are consistent with our understanding of the geometric phase effect.

Goal (Completion Dates): Construct the 3He coil. It is crucial for the 3He injection tests but is a conventional job that can be given to industry. The funds need to be identified. (2/1/07)

Risk Descriptions: So long as it is done, there is very little risk.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Marginal	Low	
Schedule	Unlikely	Marginal	Low	
Cost	Likely	Significant	Medium	

CPM Actions: Identify the supplementary funding needed build the 3He holding coil.

WBS	1.1.2.6	**Title**	High voltage studies
Funding Source	LDRD	**Institutions**	Indiana, LANL
Funding Avail.	$140k	**Opportunity**	

Goal (Completion Dates): Completion of measurements of the dielectric strength of LHe down to 1.8k to see if it continues going down. Perfecting our LHe purification techniques. (12/1/06)

Risk Descriptions: This work is almost complete.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Marginal	Low	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: None

Goal (Completion Dates): Measure the leakage current along pure acrylic and dTPB coated acrylic. The measurement should be less than 1 nA. If the schedule allows, put in a reasonable mockup of the actual cell geometry. (3/1/07)

Risk Descriptions: Coating the acrylic somehow makes a path for surface currents that can produce a false EDM effect.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Significant	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support this work.

WBS		Title	High voltage studies continued
Funding Source		**Institutions**	
Funding Avail.		**Opportunity**	

Goal (Completion Dates): Select the final electrode material. This material should be a good enough conductor to maintain the ground plane but not so good that it introduces eddy currents or Johnson noise for the SQUIDs. The material will need to have its resistance measured as a function of temperature from 0.3-4.0 K. It also must contain only very small amounts of materials that are activated by neutrons. (2/1/07)

Risk Descriptions: This task should be made reasonably easy by consultation with the LANL materials scientists.

Risk	Likelihood	Impact	Overall Risk	
Technical	Unlikely	Marginal	Low	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support this work.

Goal (Completion Dates): Measure the dielectric strength of LHe down to 0.3 K. The goal is to obtain a field of at least 50 kV/cm. If only 30 kV/cm is obtainable, a decision as to whether to pressurize the LHe must be made. Pressurization will induce more stringent specifications on the valves. These tests require the new cryostat, now in construction, to function with the dilution refrigerator. (12/24/07)

Risk Descriptions: The low temperature regime is a largely unknown, with anecdotal information in the literature that implies poor performance. It is also uncertain whether pressurization will cure the problem. The schedule to perform the tests at 0.5K is quite tight due to the need for a new cryostat, especially when coupled to the 3He injection tests.

Risk	Likelihood	Impact	Overall Risk	
Technical	Likely	Critical	High	
Schedule	Likely	Significant	Medium	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the Indiana-LANL effort. Increase the scientific staffing. Make sure each test (~1mo) is well planned. Work to an aggressive schedule. Redirect engineering and LANL technician resources to the construction of the new cryostat.

WBS	1.1.2.7	**Title**	4He evaporative purification
Funding Source	LDRD	**Institutions**	NCSU
Funding Avail.	$100k	**Opportunity**	

Goal (Completion Dates): Demonstrate the operation of the 4He evaporative purifier. It needs to remove the 3He from LHe from 1 part in 10^{10} to one part in 10^{12}. The regeneration time needs to be roughly once in 6 hours, which means controlling the film flow. The operation must be characterized as a function of temperature from 0.2-0.6 K, and the time to purify needs to be measured. A time of less than a few minutes is needed to limit the dead time for the experiment. (12/24/07)

Risk Descriptions: The film flow will not be controllable with a conventional film burner or the heat required will be too great near the operating temperature of the experiment. Alternatively, the collaboration may have misunderstood the mechanism for evaporative purification.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Likely	Critical	High	
Schedule	Unlikely	Significant	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support this work.

Goal (Completion Dates):

Risk Descriptions:

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.2.8	**Title**	SQUID NMR signal
Funding Source	LDRD	**Institutions**	Yale, Indiana, LANL
Funding Avail.	$125k	**Opportunity**	

Goal (Completion Dates): The requirement is to design a SQUID system to observe the polarized 3He precession with a S/N of about 20 so that the measurement does not significantly contribute to the EDM sensitivity. The choice between pickup loops and gradiometers needs study. The signal should be about 100 $\mu\Phi_0$ and the background should be 5 $\mu\Phi_0/\sqrt{\text{Hz}}$. In principal, these requirements are standard technology, but a demonstration of the sensitivity would be reassuring. (9/1/07)

Risk Descriptions: There is a concern about microphonics putting noise on the SQUIDs. The gradiometer greatly reduces the noise at the expense of signal. The challenge is to find the optimal design for the polarized-3He detection system with a manageable number of SQUIDs.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Get Yale to organize the three institution effort, taking advantage of the expertise at each site. Coordination will be important. Support the effort. Negotiate priorities with the LANL group whose expertise is useful but whose main research is in physical biology.

Goal (Completion Dates): Operate a SQUID in the region of the electric field. (3/1/07)

Risk Descriptions: If microdischarges make noise in the SQUIDs, the S/N could be adversely affected. Other groups have not seen these problems at lower electric fields.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions:

WBS	1.1.2.9	Title	3He injection
Funding Source	DOE Constr.	**Institutions**	Duke
Funding Avail.	$60k	**Opportunity**	

Goal (Completion Dates): This measurement takes the 3He from the atomic beam source (ABS) and injects it into the collection volume, where it is held until needed. The main issues are the elimination of depolarization regions and the control of the superfluid film flow. The heat load from the ABS must be measured. A 3He concentration significantly higher than 10^{-10} must be achieved. The requirement of the new cryostat and sharing with the high voltage studies requires careful coordination. (12/24/07)

Risk Descriptions: The concern is that the ABS and a film burner will provide a lot of heat to the cryogenics. If a Cs coating is tried, it may be easily contaminated. If there are areas that have the wrong materials exposed, the 3He may depolarize. The technology is known, but it requires careful work to achieve all these requirements simultaneously.

Risk	Likelihood	Impact	Overall Risk	
Technical	Likely	Critical	High	
Schedule	Likely	Significant	Medium	
Cost	Unlikely	Marginal	Low	

CPM Actions: Support the Duke effort. Get help for the Duke team, perhaps from MIT. Keep Duke focused on this important goal. Make sure each test (~1mo) is well planned. Work to an aggressive schedule. Redirect engineering and LANL technician resources to the construction of the new cryostat.

Goal (Completion Dates):

Risk Descriptions:

Risk	Likelihood	Impact	Overall Risk	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.2.10	**Title**	Laser induced fluorescence
Funding Source	DOE Constr.	**Institutions**	Yale
Funding Avail.	$50k	**Opportunity**	

Goal (Completion Dates): Demonstrate the observation of a signal from pumping the triplet dimers in LHe generated by ionizing radiation. Show that the optical pumping scheme works with small laser power. Show that the laser light can be filtered before the PMTs. (12/1/07)

Risk Descriptions: The advisory committee was split on this research, some saying that it would never find its way into the project, and some saying it provided an important alternate signal. The major technical questions are the total energy dropped by the laser and the final de-excitation of the triplets.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Likely	Marginal	Low	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Have more conversations with the Yale proponent. Make a decision quickly on whether to fund or not. The funds could provide useful contingency.

Goal (Completion Dates):

Risk Descriptions:

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.2.11	**Title**	Slow controls
Funding Source	DOE Constr.	**Institutions**	NCSU
Funding Avail.	$50k	**Opportunity**	

Goal (Completion Dates): Build a prototype slow controls system using EPICS so that it will be ready to be distributed as soon as needed. (3/1/07)

Risk Descriptions: The advisory committee saw no reason to build a prototype at this time. They recommended that the subsystem manager establish standards for the purchase of control electronics. They also recommended coordination of the simulation efforts.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Marginal	Low	
Schedule	Unlikely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Withhold funding of this effort. Use the funds as contingency for the other R&D efforts. Encourage the development of standards for the collaboration so that teams buying control equipment get EPICS compatible hardware.

Goal (Completion Dates):

Risk Descriptions:

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical				
Schedule				
Cost				

CPM Actions:

WBS	1.1.1.2	**Title**	Neutron storage time
Funding Source	LDRD	**Institutions**	LANL, Caltech
Funding Avail.	$20k	**Opportunity**	

Goal (Completion Dates): Measure the storage time for UCN in a deuterated styrene bottle using the solid deuterium. The goal is a storage time of ~500 sec. The preliminary value of ~300 sec is already good enough to move forward with the experiment. The preliminary result should be reproduced with better statistics. (1/1/2007)

Risk Descriptions: Preliminary indications are that the goal is likely attainable. The availability of the UCN beam at LANL remains questionable. Preliminary results mitigate the need for this test, but a more reliable result would be reassuring. There is some chance that the UCN source will not be available, but another attempt is possible in the Summer of 2007.

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical	Unlikely	Critical	Medium	
Schedule	Likely	Marginal	Low	
Cost	Unlikely	Marginal	Low	

CPM Actions: Continue to work with the UCN beam developers to get the necessary experiments scheduled.

Goal (Completion Dates):

Risk Descriptions:

Risk	**Likelihood**	**Impact**	**Overall Risk**	
Technical				
Schedule				
Cost				

CPM Actions: