Project Overview & Planning

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Docs: PMP & NYSERDA SOW

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Introduction

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Test & develop a multi-turn ERL using a single FFAG return loop with an energy acceptance factor of up to 4.

Relocate Cornell's existing:

- Gun with its laser system
- Injector Cryo-Module
- Merger system
- High-power beam stop

The Main-Linac Cryomodule (MLC) is already located in the L0E hall.

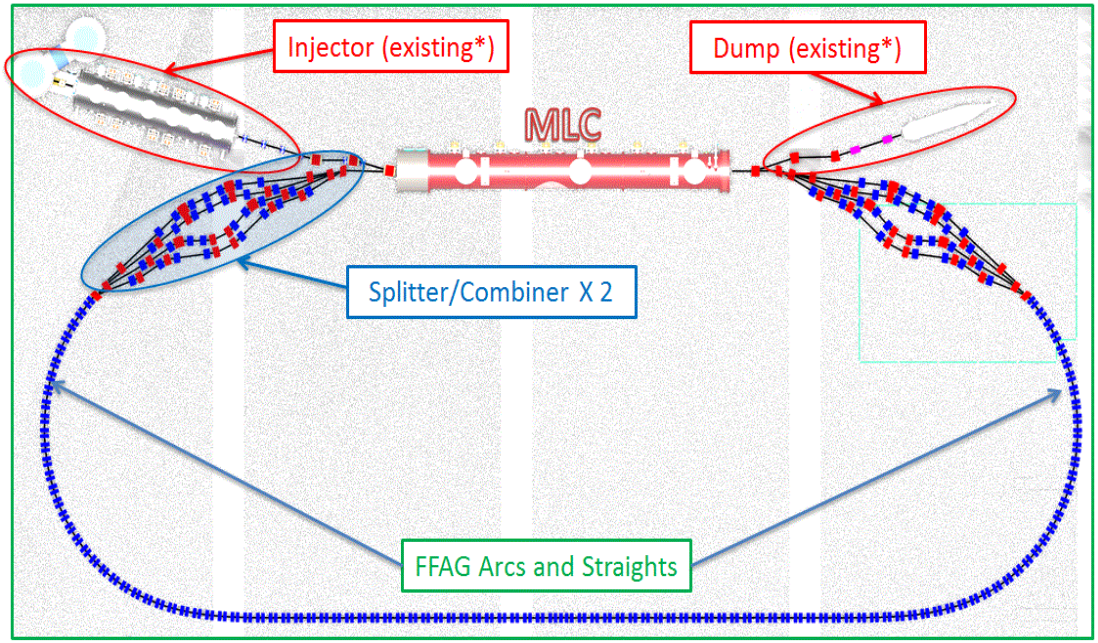
Move the associated RF-power system, cryogenic system, & electrical controls.

Install a single FFAG return loop for multi-turns with separator & combiner sections that connect the arc to the MLC.

Commission & operate with at least 1 mA, increasing toward the expected limit of 40 mA.

Total current is 320 mA: 4 accelerating & 4 ER passes.

Existing & new equipment



Much equipment & infrastructure exists — 32 M$!

MLC beam test in spring/summer 2017

Major new equipment:

- 2 spreader-combiners (electromagnets & tables)
- FFAG hybrid permanent magnet arc

Layout review feedback (June 15&16)

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"The existing Cornell infrastructure is very well leveraged and should be emphasized in future project presentations.

The photo-injector and main linac cryomodule are notable in this regard."

Approximately 32 M$

Project Management Plan
&
NYSERDA Statement of Work

Project Management Plan

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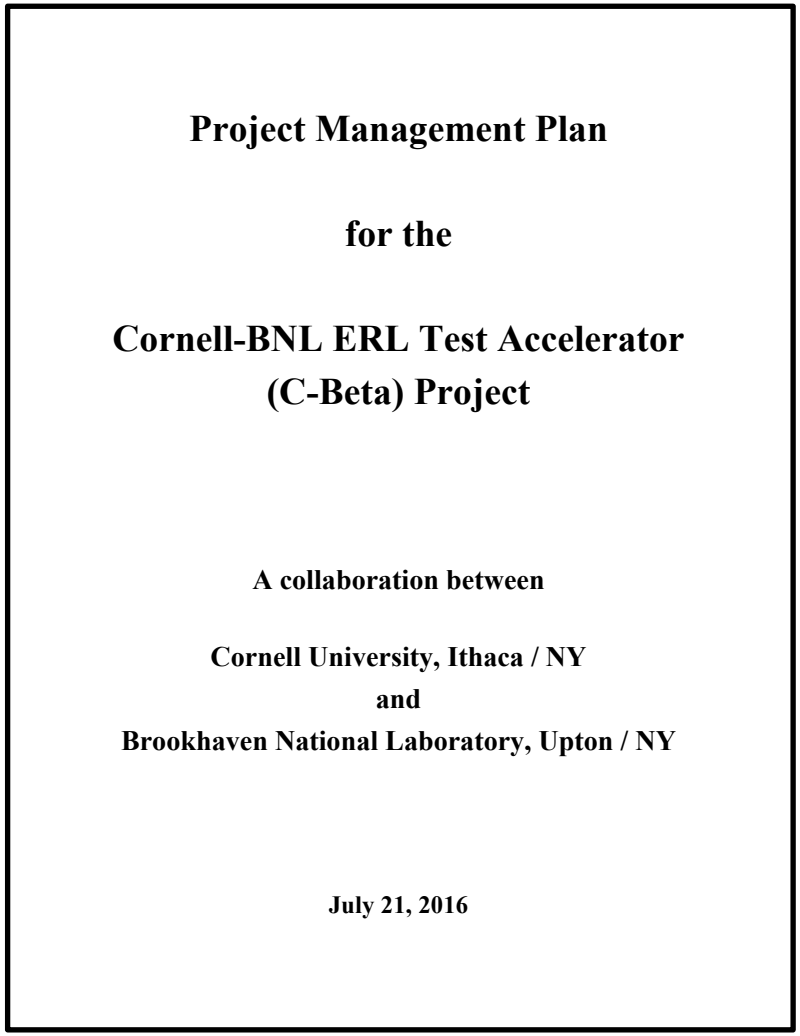
Project Mgmt Plan (July 21)

- Is stable
- Will evolve slowly
- See Indico



Project Management Plan

for the

Cornell-BNL ERL Test Accelerator (C-Beta) Project

A collaboration between

Cornell University, Ithaca / NY
and
Brookhaven National Laboratory, Upton / NY

July 21, 2016

Layout review:

"The evolving project management plan should be capable of meeting the requirements of all stakeholders.

There has been considerable progress recently and it is close to completion.

More detail in regard to the roles and responsibilities of the Project Managers and the Principle Investigators is encouraged."

More detail in this presentation, below.

NYSERDA Statement of Work

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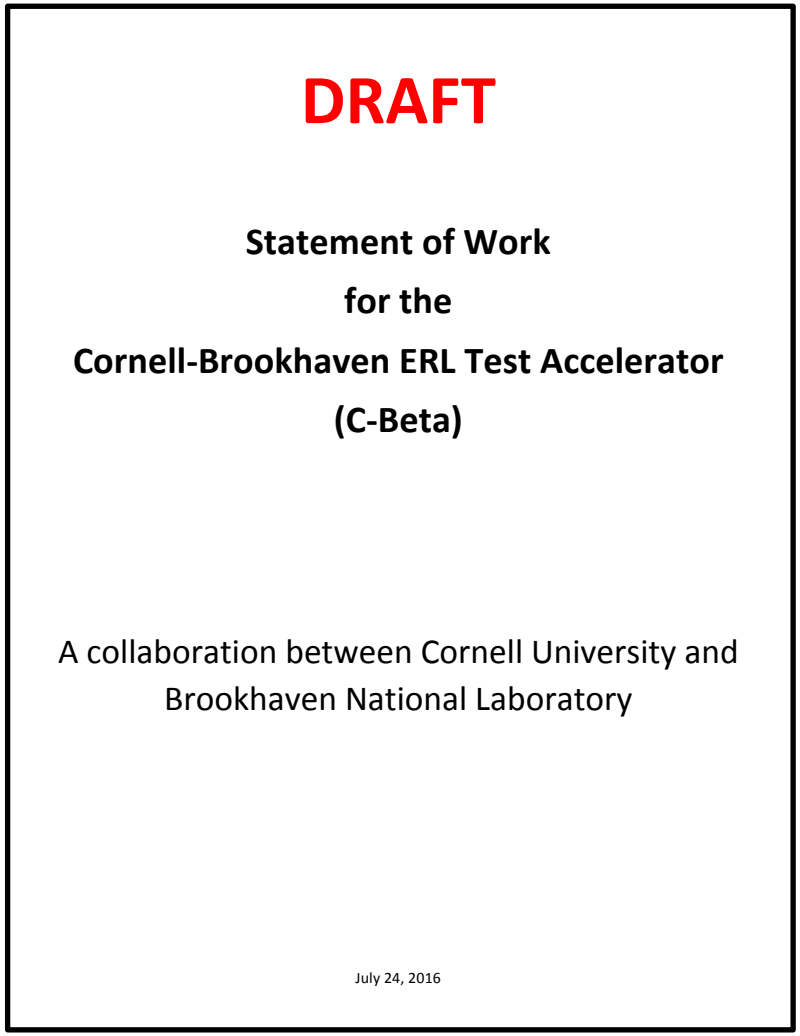
Statement of Work (July 24)

- Is a DRAFT
- Deliver by early August for external review
- Key documentation for September 20 Board meeting

We welcome your feedback.

Some topics may need to be closed door.



Technical timeline - pending funding

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The 40-month technical timeline is a high-level summary of the schedule of the Work Breakdown Structure (WBS).

Technical milestone	Months	Comment
NYSERDA funding start date	0	Estimate: Oct 2016
Prototype girder	6	
Spreader and combiner production approved	8	
Prototype girder testing complete	8	PM production approved
Beam through Main Linac Cryomodule	10	Go/no go 1
Fractional Arc Test: Beam through MLC + prototype girder	18	Go/no go 2
Girder production run complete	25	
Final assembly and pre-beam commissioning	28	
Single pass, x2 energy scan	32	
Single pass, Energy Recovery	36	Key parameters achieved
Four pass with Energy Recovery (low current)	38	
Project completion	40	Estimate: Feb 2020

Go/no go milestones

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Two “go/no go” milestones, at months 10 & 18.

First: after beam has been accelerated through the Main Linac Cryomodule.

The MLC will be moved into its final location for beam testing that will be completed in summer 2017.

Second: after the Fractional Arc Test (FAT) that will see beam also pass through an initial configuration of one combiner-separator and a prototype girder.

Budget profile

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Current “11 deliverable” model in SOW:

Index	Deliverable	Completion month	Cost $M
D01	Engineering design	3	2.0
D02	Infrastructure preparation	5	1.4
D03	SRF injector, linac RF components, RF controls	8	1.7
D04	Cryogenic equipment	8	0.8
D05	Shielding and safety systems	11	1.2
D06	Hybrid permanent magnets	11	3.9
D07	Power and instrumentation	14	3.1
D08	Vacuum system and beam transport	17	2.6
D09	Beam spreader-combiners (Turns 2-4)	23	3.5
D10	Final assembly and installation	26	2.3
D11	Commissioning and testing	38	2.5

Layout review:

"The project technical milestones must be consistent with NYSERDA's milestones for triggering payments."

We believe that a "monthly payment" schedule is possible, in place of the "11 deliverable" model.

Fractional Arc Test
&
performance parameters

Fractional Accelerator Test

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Prototype girder (constructed at 6 months):

- 4 cells, 8 hybrid permanent magnets, stamped laminations, final tooling & permanent magnet blocks
- 1.7 m long, 20 degree bend angle

The FAT commissions as much C-Beta equipment as is practically possible before making a final commitment to constructing and assembling the rest of the accelerator.

- 2 girders?

FAT is an integration test and a beam test

- early validation of the eRHIC FFAG concept

Scan energy by a factor of 2

Layout review:

"We note that the results of cBeta could have strong cost implications for eRHIC, but the window of opportunity to use this information is finite.

There are many factors which help determine the cBeta schedule but the eRHIC program is an important contributor."

Performance Parameters

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Key Performance Parameters, when met, enable a "CD4" success declaration

Stretch parameters are the ultimate goal

This is a prototype — how far is the stretch ?

Parameter	Unit	KPP	Stretch
Electron beam energy	MeV		150
Electron bunch charge	pC		123
Gun current	mA	1	40
Bunch repetition rate (gun)	MHz		325
RF frequency	MHz	1300	1300
Injector energy	MeV		6
RF operation mode			CW
Number of ERL turns		1	4
Energy aperture of arc		2	4

Layout review:

"The key performance parameters presented during the review for CD4 are appropriate for the formal completion of the project."

WBS, costs & control

Work Breakdown Structure

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1.1	**Project management:**	Steve Peggs (BNL)
1.2	**Design & accelerator physics:**	Chris Mayes (CU)
1.3	**DC electron source:**	Karl Smolenski (CU)
1.4	**Injector & Main Linac:**	Fumio Furuta (CU)
1.5	**Hybrid magnets & girders:**	Holger Witte (BNL)
1.6	**Electromagnets & girders:**	George Mahler (BNL)
1.7	**Power supplies:**	John Barley (CU)
1.8	**Instrumentation & controls:**	John Dobbins (CU)
1.9	**Vacuum system & beam stop:**	Yulin Li (CU)
1.10	**Cryogenics:**	Dan Sabol (CU)
1.11	**Infrastructure:**	Rich Gallagher (CU)
1.12	**Commissioning:**	Adam Bartnik (CU)
1.13	**Safety:**	Brian Heltsley (CU)

WBS (2)

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WBS is being expanded to L3, prior to a bottom-up derivation of cost, schedule, scope & risk.

Critical BNL responsibilities are:

- 1.1 Project Management (Steve Peggs)
- 1.5 Hybrid magnets & girders (Holger Witte)
- 1.6 Electromagnets & girders (George Mahler)
  - 1.8.n Beam Position Monitors (Rob Michnoff)

There is considerable CU/BNL intermingling at L3.

Modest (slow) evolution is possible at L2.

Cost baseline by WBS

The Total Estimated Cost of $25.0M includes contingency.

Cost estimates are being developed bottom-up.

- Scope will be limited, as necessary, to meet TEC.

All L2 items are assigned a contingency that will change continuously as more information becomes available.

The total contingency allocation is close to 30%.

The total contingency of $5.7M will not be exceeded.

PMs & L2 CAMs specify contingencies at least down to L3.

Contingencies are owned by the Management Board.

Earlier cost summary (old WBS)

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Cost includes equipment, M&S & labor.

Includes university overhead & C-Beta infrastructure costs.

Details in Karl's presentation.

WBS	Description	Cost (k$)	Contingency (k$)	Total (k$)
1	C-Beta	19,300	5,700	25,000
1.1	Project Management	700	150	850
1.2	Design and Accelerator Physics	1200	380	1,580
1.3	Injector and Dump	600	125	725
1.4	Linac and LLRF	1500	315	1,815
1.5	Permanent Magnets, Girders	3200	1045	4,245
1.6	Conventional Magnets, Girders	3200	1045	4,245
1.7	Power Supplies	1,400	305	1,705
1.8	Instrumentation and Controls	2,100	685	2,785
1.9	Vacuum System	1,600	530	2,130
1.10	Cryogenics	700	150	850
1.11	Infrastructure and Installation	1,300	420	1,720
1.12	Commissioning	1,400	455	1,855
1.13	Safety Systems	400	90	490

Risk Management

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Risks will be managed with a Risk Register, including:

- risk
- consequences
- mitigation strategies

Contingency (about 30%) enables mitigation.

Change control

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Level	Cost	Schedule and Risk	Technical Scope
Oversight Board	Costs needs that surpass the total project cost	Project Milestones, Review Milestones, review scopes	Changes of Key Performance Parameters and design parameters
Management Board	Contingency allocations	L2 subsystem completion dates and risks	Baseline changes, after consultation with the Baseline Control Board
Project Manager & Deputy Project Manager	Allocations at L2 larger than $10k, without contingency	Milestone changes that do not affect L2 completion dates or risks	Changes that do not affect the baseline
Cost Account Managers	Allocations at L3 less than $10k, without contingency	Changes that do not affect L3 milestones	Changes that do not affect technical deliverables

Construction Readiness Reviews

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Each WBS Level 2 (L2) subsystem will undergo a Construction Readiness Review.

Reviews will be bundled, where appropriate.

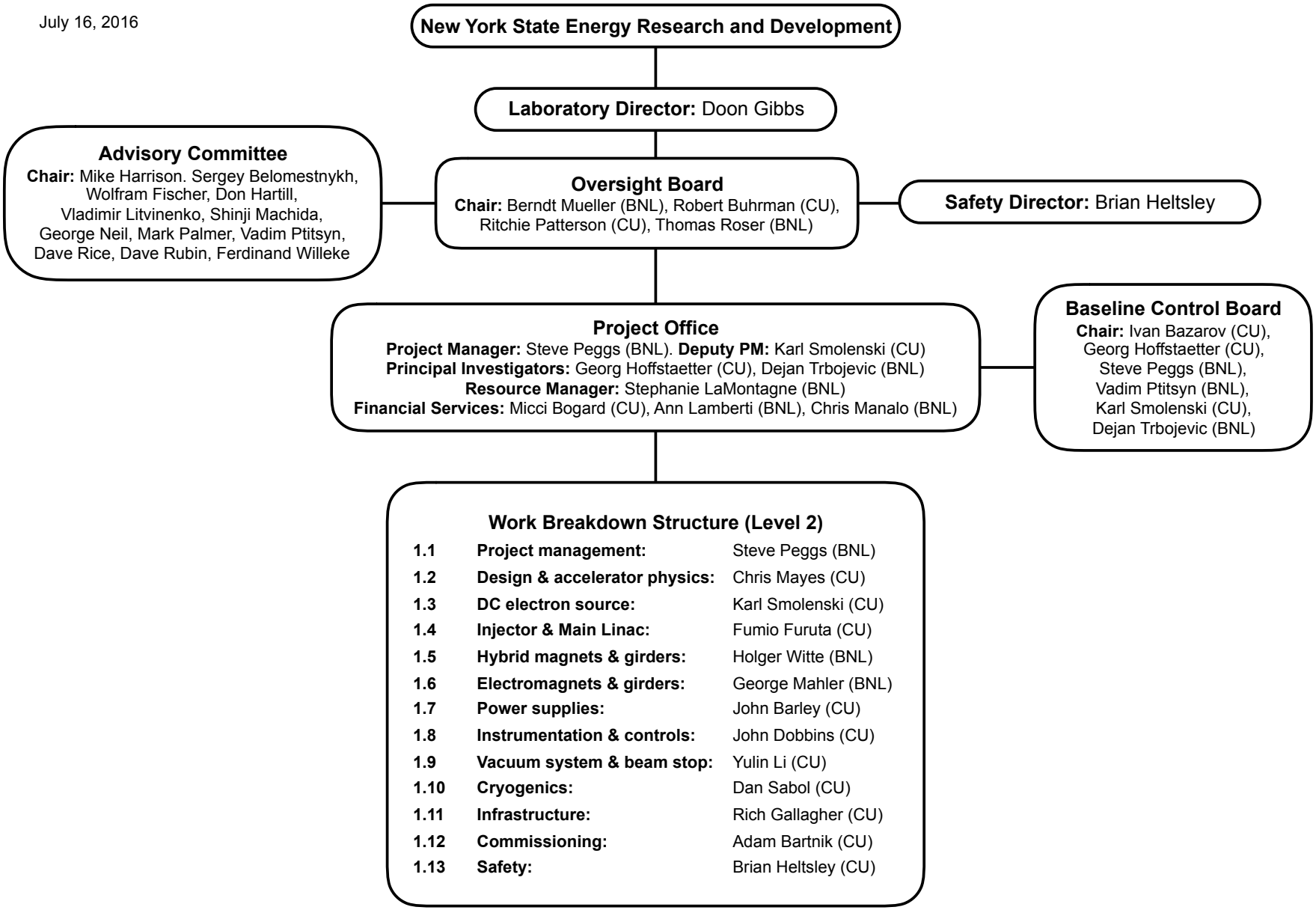
Technical design report & cost estimate will be reviewed.

Oversight Board gives final approval for construction start.

Management structure

Organization Chart (July 16)

July 16, 2016



Oversight Board

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Two BNL & two Cornell members, chaired by BNL.

Works with funders to secure timely delivery of funding.

Receives advice from the Advisory Committee.

Makes changes to the Management Board or Advisory Committee, as needed.

Reviews top level changes.

Reviews monthly reports from the Management Board & calls meeting if these should be discussed.

Receives review reports, approves the reviews, & shares them with the Project Management.

Approves construction start of each WBS L2 subsystem.

Layout review:

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"*We note the importance of the Oversight Board in institutional communication and encourage the Project Office to make this an effective channel, in view of the possibility of resource conflicts.*"

Advisory Committee

Chair & membership are suggested by the Management Board & approved by the Oversight Board.

Chair is consulted in forming its membership.

Is a standing committee that can be asked for advice by both the Management Board & the Oversight Board.

Is invited to the C-Beta site at least annually.

Provides written reports of its findings.

Management Board

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4 members: 2 Principal Investigators, Project Manager from BNL, Deputy Project Manager from CU.

All members also belong to the Baseline Control Board.

Resolves resource conflicts.

Approves the use of contingency, schedule, & scope changes.

Prepares a monthly report for submission to the Oversight Board.

Makes changes to the BCB or the PCB, as needed.

Presents the status of the project in Advisory Committee meetings.

Meets at least weekly, either face-to-face or on the phone.

Technical decisions are made unanimously. If not possible, the Advisory Committee or a suitable group of technical experts is consulted.

Scheduling & financial decisions are made unanimously. If not possible, the Oversight Board is consulted.

Principal Investigators

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Primary contacts for the project to the outside world.

Co-ordinate to organize reviews (scope, charge, dates, membership).

Work to establish Key Performance Parameters, design parameters, technical scope, resource loaded schedule & BNL & CU needs.

Co-ordinate preparation of major documents (eg Design Reports).

Participate in hiring decisions of technical staff who will be paid by the project.

Resolves resource conflicts within the project.

Organize a Publications and Speakers Committee.

Project Manager & Deputy

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The PM & the DPM manage the execution of the L2 subsystems at their respective institutions, especially 1.1 Project Management.

Work with the CAMs to establish WBS structure and establish intermediate milestones.

Ensure that project activities are conducted in a safe & environmentally sound manner.

CLASSE & Cornell safety requirements apply for work at Cornell.

Local DOE safety rules apply for work at BNL.

Validate labor charges.

Provide a monthly estimate at complete & milestone status to the Oversight Board.

Approves the use of contingency, scope changes, & schedule changes.

Baseline-design parameters

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Project Manager maintains the spreadsheet-based "database" of baseline-design parameters. Eg "high-level":

High level (S. Peggs)					23-Jul-16
Parameter	**Unit**	**Value**	**Status**	**Date**	**Comment**
Harmonic number		333	Active	30-Mar-16	
		335	Draft	23-Jul-16	Proposed change !
KEY PERFORMANCE PARAMETERS					
Number of ERL turns		1	Active	30-Mar-16	
Injector energy	MeV	6	Active	30-Mar-16	
Top energy (1 turn)	MeV	42	Active	30-Mar-16	
Gun current	mA	1	Active	30-Mar-16	
Bunch repetition rate	MHz	325	Active	30-Mar-16	
Energy aperture		2	Active	30-Mar-16	
DESIGN (ULTIMATE) PARAMETERS					
Number of ERL turns		4	Active	30-Mar-16	
Top energy (4 turns)	MeV	150	Active	30-Mar-16	
Gun current	mA	40	Active	30-Mar-16	
Electron bunch charge	pC	123			
Bunch repetition rate	MHz	325	Active	30-Mar-16	
Bunch repetition rate, max	MHz	1300	Active	30-Mar-16	
Energy aperture		4	Active	30-Mar-16	

Baseline Control Board

Acts when baseline-design parameter changes are requested.

- Eg increase harmonic number from 333 to 335 ?

Chair from CU, from outside Management Board.

Decisions are made by consensus whenever possible.

If necessary, the Advisory Committee is consulted.

Project Office

Includes the Management Board, a resource manager from BNL, & financial services support from BNL & CU.

Is accountable to the Project Manager.

Tracks financial progress.

Coordinates with CLASSE & C-AD to gather appropriate financial information.

Provides monthly financial reports.

Conclusion

Layout review:

"Recommendation: The Project needs an updated cost estimate and associated schedule."

This is urgent.

We have begin the process.

The process will be iterative:

1) At first, to achieve better and more detailed data
2) Later, to adapt to evolving circumstances

Summary

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The management structure is in place

The WBS is evolving to L3

Level 2 leaders are on board and motivated

The tools are in place to develop:

- Bottom-up cost estimate
- Schedule
- Scope (to maintain $25M TEC)
- Risk management

Without compromising safety at BNL or Cornell

We welcome your support and detailed feedback!

Layout review:

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"Considerable pre-project work has been carried out to date.

The initial funding stream for the project has now begun.

The project will face significant challenges to be completed within the fixed total project cost. In this regard we feel an updated baseline cost estimate is crucial.

The upcoming review in September is an opportunity to carry this out."

So be it.