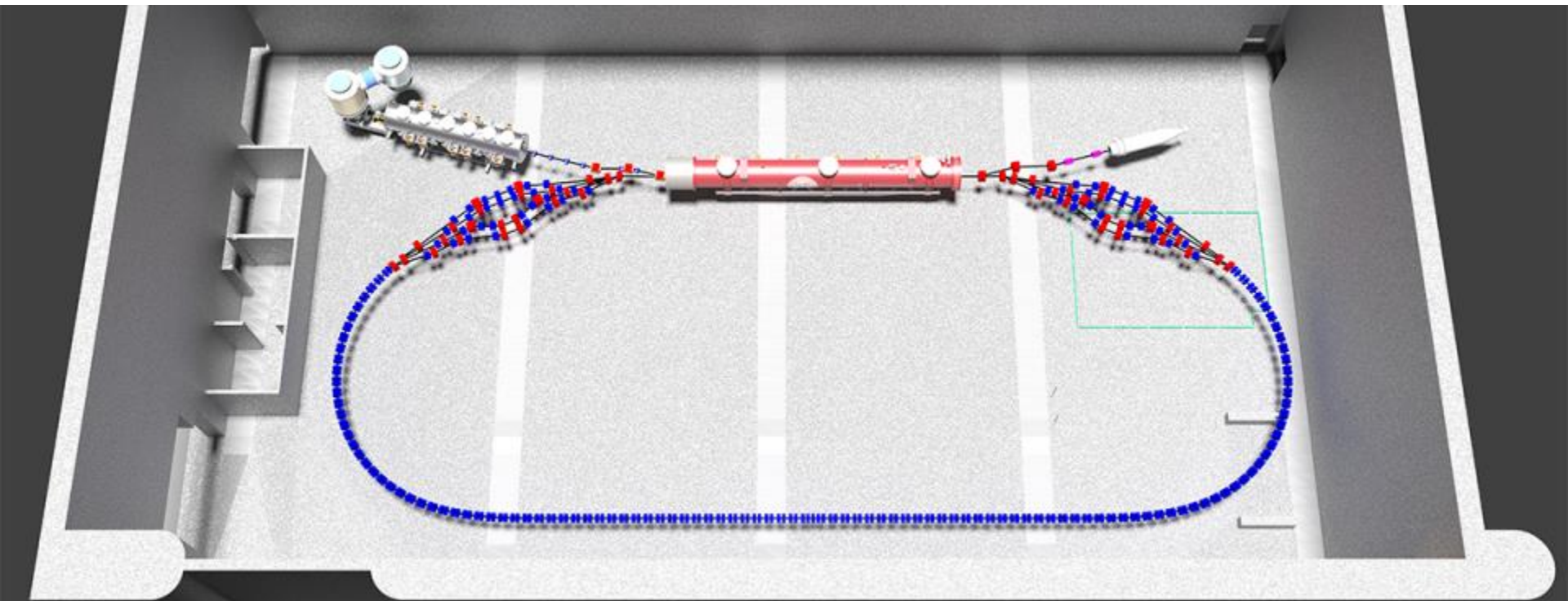




CORNELL-BNL ERL TEST ACCELERATOR



## **Cost and Schedule Status and Planning**

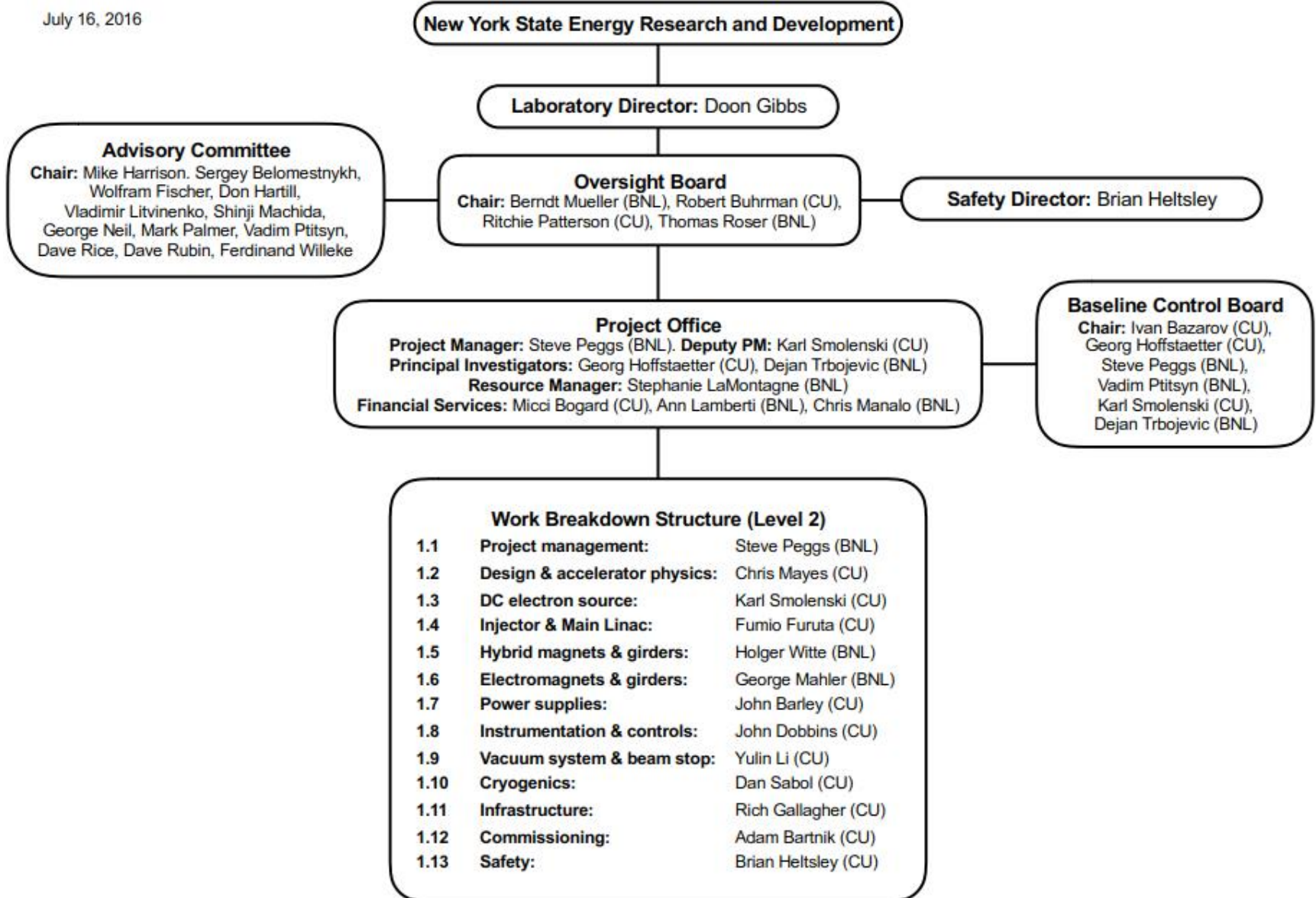
**Karl Smolenski for the Cornell and  
Brookhaven Teams**

- Cost Analysis
- Schedule Development
- Risk Analysis
- EH&S

# Review Process - Timeline



July 16, 2016

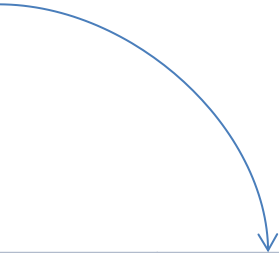


## Work Breakdown Structure (Level 2)

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 7 - Example

WBS	Manager	Name
<b>1.7</b>	<b>Barley</b>	<b>Power Supplies</b>
<b>1.7.1</b>		<b>Dipole power supplies</b>
<b>1.7.2</b>		<b>Quadrupole power supplies</b>
<b>1.7.3</b>		<b>Trim Coil supplies</b>
<b>1.7.4</b>		Milestone: Power supplies ready



WBS	Manager	Name
1.7.1.1		Engineering design
1.7.1.2		Specifications
1.7.1.3		Procurement/Vendor Interface
1.7.1.4		Rack Mounting and local wiring
1.7.1.5		Controls interface
1.7.1.6		QA and testing

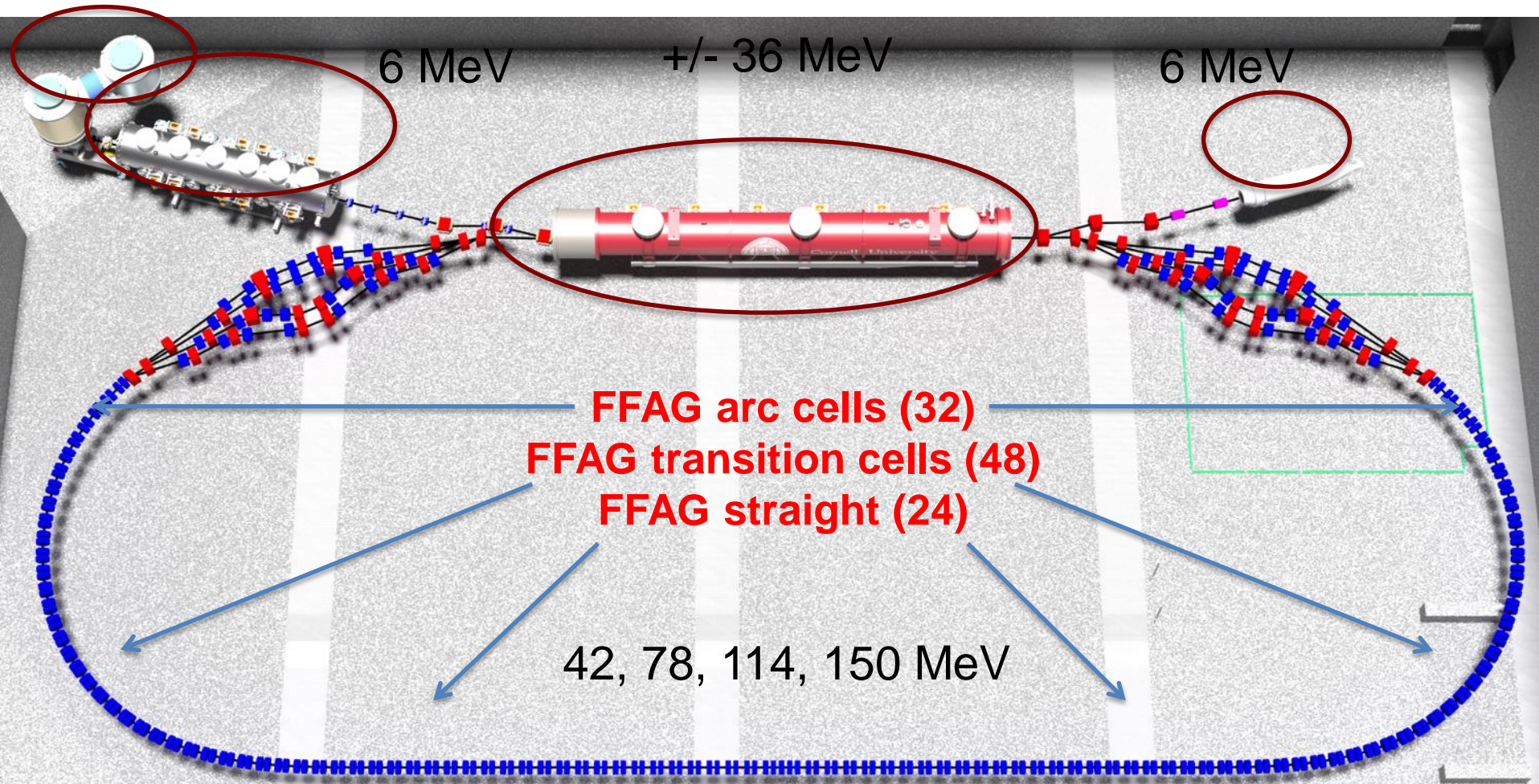
## Work Breakdown Structure (Level 2)

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1.13	Safety:	Brian Heltsley (CU)

# CBETA: The FFAG loop



- Cornell DC gun
- 100mA, 6MeV SRF injector (ICM)
- 600kW beam dump
- 100mA, 6-cavity SRF CW Linac (MLC)





*L0E contained approximately 7,000 square feet of Lab and Shop space*



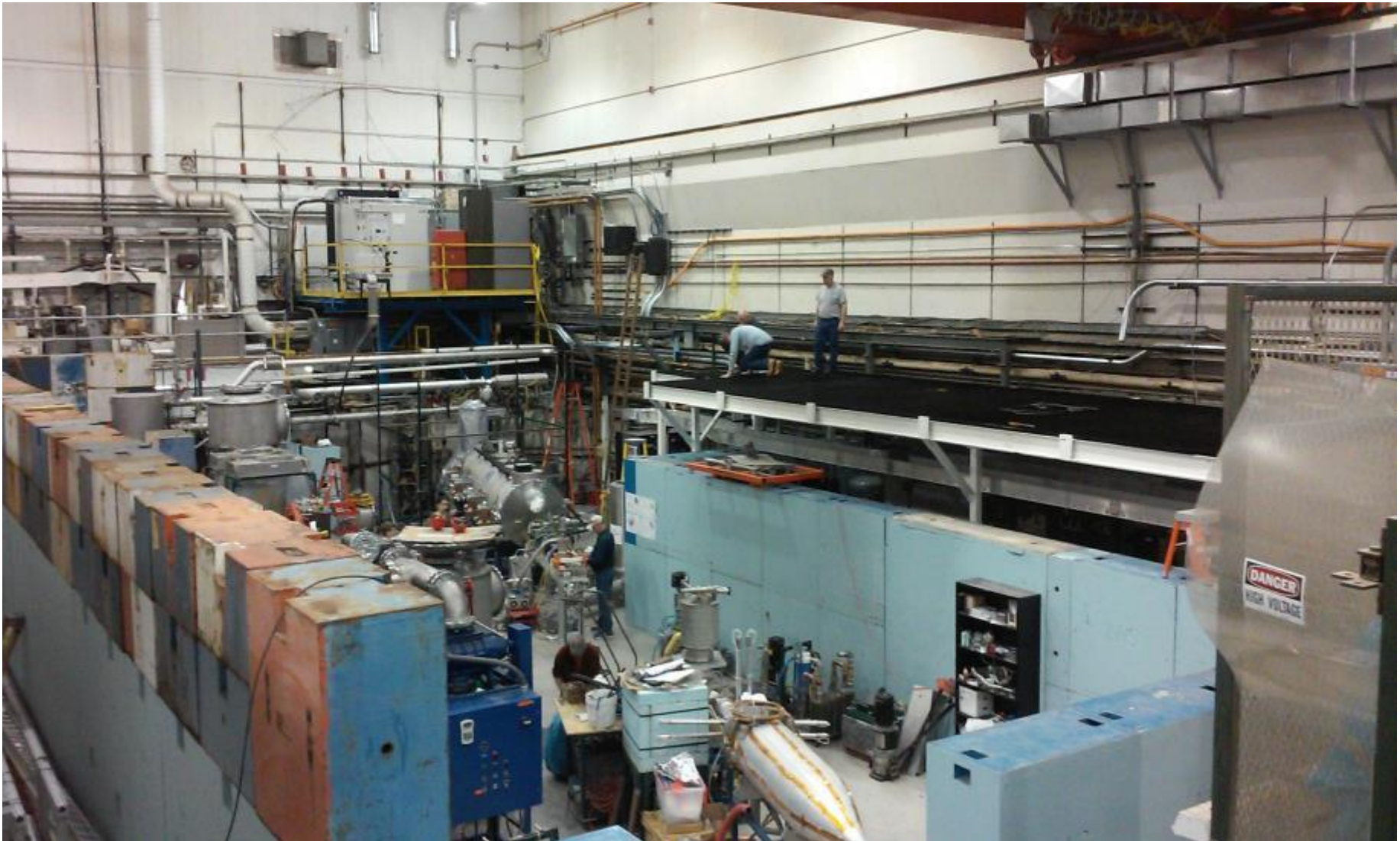
*70% of the existing technical-use space was removed for the initial phase*



*The initial installation was completed for the MLC and ERL beamline*

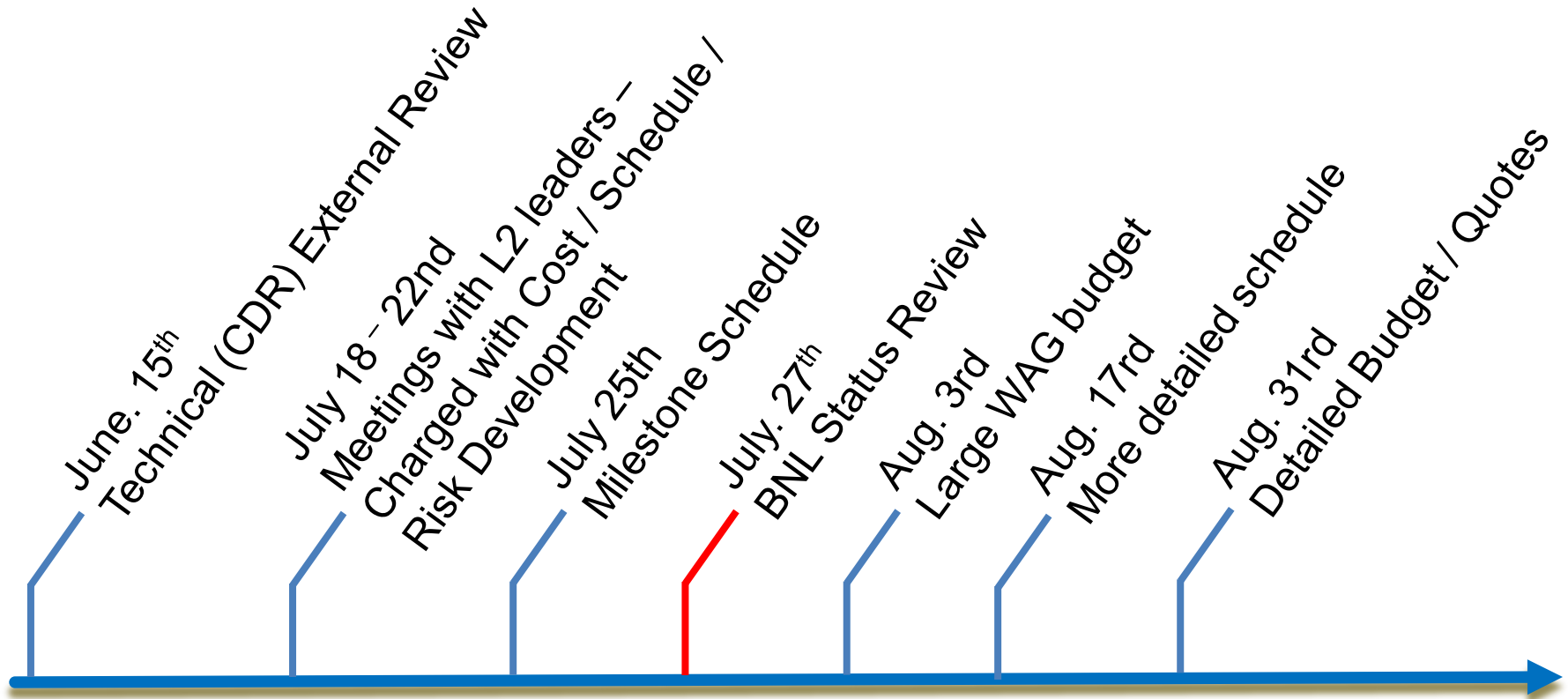



The second phase will accommodate the new loop-layout



*The second phase is almost complete*





	<h2>CORNELL – BROOKHAVEN CBETA</h2>	<b>Date of Est:</b> 14 July 2016 Edited: 14 July 2016
		<b>Prepared by:</b> <b>Responsible Inst:</b> Cornell University
		<b>Docdb #:</b>
<b>WBS number:</b> 1.1.1.1	<b>WBS Title:</b>	
<b>WBS Dictionary Definition:</b> INSERT YOUR TEXT HERE		
<b>Estimate Type (check all that apply – see BOE Report for estimate type by activity):</b>  <input type="checkbox"/> Work Complete <input type="checkbox"/> Existing Purchase Order <input type="checkbox"/> Catalog Listing or Industrial Construction Database <input type="checkbox"/> Documented Vendor Estimate based on Drawings/ Sketches/ Specifications <input type="checkbox"/> Engineering Estimate based on Similar Items or Procedures <input type="checkbox"/> Engineering Estimate based on Analysis <input type="checkbox"/> Expert Opinion		
<b>Supporting Documents (including but not limited to):</b>		























### Details of the Base Estimate (explanation of the Work)

This BoE covers the cost of the specification, design, prototyping, production, and certification of the

INSERT YOUR TEXT HERE

- Started with an Excel template provided by BNL
- Worked with L2 Leaders to make detailed cost estimate for each section (last year)
- Added various overhead rates
- This resulted in the first-pass cost estimate shown on the next page
- Next steps after this review (June 15<sup>th</sup> CDR)
  - Have L2 Leaders revisit each section
  - Update costs based on the latest design and quotations / proposals
- **PI / PM to collect and build into schedule (MS project and cost analysis)**



 Cbeta Cost Estimate WBS Preliminary (1).xlsm	7/25/2016 11:32 A...	Microsoft Excel M...	839 KB
 Cbeta Cost Summary.xlsx	1/13/2016 11:35 A...	Microsoft Excel W...	14 KB
 Cbeta Estimate WBS 1.1 Project Management.xls	7/27/2015 6:03 PM	Microsoft Excel 97...	162 KB
 Cbeta Estimate WBS 1.2 Physics Support.xls	7/27/2015 6:03 PM	Microsoft Excel 97...	162 KB
 Cbeta Estimate WBS 1.3 Injector.xls	7/27/2015 1:33 PM	Microsoft Excel 97...	169 KB
 Cbeta Estimate WBS 1.4 Linac.xls	7/27/2015 5:56 PM	Microsoft Excel 97...	166 KB
 Cbeta Estimate WBS 1.5 Magnets.xls	7/27/2015 2:30 PM	Microsoft Excel 97...	172 KB
 Cbeta Estimate WBS 1.6 Power Supplies.xls	7/27/2015 3:13 PM	Microsoft Excel 97...	169 KB
 Cbeta Estimate WBS 1.7 Beam Instrumentation.xls	11/12/2015 8:24 A...	Microsoft Excel 97...	170 KB
 Cbeta Estimate WBS 1.8 Beam Dump.xls	7/27/2015 5:46 AM	Microsoft Excel 97...	167 KB
 Cbeta Estimate WBS 1.9 Vacuum and Beam Lines.xls	7/27/2015 8:35 AM	Microsoft Excel 97...	173 KB
 Cbeta Estimate WBS 1.10 Controls.xls	7/27/2015 12:29 PM	Microsoft Excel 97...	170 KB
 Cbeta Estimate WBS 1.11 Cryogenics.xls	7/27/2015 7:04 AM	Microsoft Excel 97...	168 KB
 Cbeta Estimate WBS 1.12 Infrastructure.xls	7/27/2015 6:41 PM	Microsoft Excel 97...	170 KB
 Cbeta Estimate WBS 1.13 Installation.xlsx	7/29/2015 4:16 PM	Microsoft Excel W...	55 KB
 Cbeta Estimate WBS 1.14 Commissioning.xls	7/27/2015 6:08 PM	Microsoft Excel 97...	119 KB
 Cbeta Estimate WBS 1.15 Safety.xls	7/27/2015 5:47 AM	Microsoft Excel 97...	167 KB
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 Cbeta Estimate WBS summary.xls	11/6/2015 6:26 AM	Microsoft Excel 97...	1,971 KB
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 Cbeta revised draft budget 3 months 2016 v2.xlsx	1/25/2016 4:42 PM	Microsoft Excel W...	51 KB
 Cbeta revised draft budget Jan.March 2016.xlsx	12/22/2015 12:14 ...	Microsoft Excel W...	53 KB

# First Pass Cost Estimate



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

# Cost Example



## Partial list of tasks/costs for Linac/RF

Task description	Resource Type	hours	Material \$
Design/Layout In Test Area	CU - Engineer	320	
480 AC power, material	Purchases<\$25K		4000
480 AC power, installation	CU - Technician	80	
Cooling Water, material	Purchases<\$25K		3000
Cooling Water, installation	CU - Technician	80	
7 Solid Stae Amplifiers (SSA)	Purchases>\$25K<\$2M		450000
7 Solid Stae Amplifiers (SSA) installation	CU - Technician	160	
7 Circulators	Purchases>\$25K<\$2M		70000
7 Circulators installation	CU - Technician	160	
7 Coaxial waveguide and connectors, material	Purchases>\$25K<\$2M		26000
7 Coaxial waveguide and connectors, assembly	CU - Technician	80	
7 Coaxial waveguide and connectors, installation	CU - Technician	80	
7 Solid Stae Amplifiers (SSA), Testing	CU - Engineer	320	
Testing Hardware and fixtures	Purchases<\$25K		5000
LLRF Specification, Schematics, Documentation	CU - Engineer	480	
LLRF PCB Layout	CU - Engineer	320	
12 LLRF boards, material	Purchases>\$25K<\$2M		36000
12 LLRF boards, assembly	CU - Technician	80	
12 LLRF boards, testing	CU - Engineer	160	
8 Slow Analog I/O Boards, material	Purchases<\$25K		8000
8 Slow Analog I/O Boards, assembly	CU - Electronics Technician	160	
8 Slow Analog I/O Boards, testing	CU - Electronics Technician	80	
12 Digital I/O, material	Purchases<\$25K		3600
12 Digital I/O, assembly	CU - Electronics Technician	60	
12 Digital I/O, testing	CU - Electronics Technician	20	
12 I/O Processors, parts	Purchases<\$25K		250
12 I/O Processors, software development	CU - Engineer	320	
2 LLRF power supplies	Purchases<\$25K		3000
2 VME Crates	Purchases<\$25K		4000
FPGA Programming	CU - Engineer	320	
RF Processor Programming	CU - Engineer	320	

# Cost Example – Magnet Power Supplies



**BIRA**

2410 Midtown Pl  
Albuquerque, NM  
87107 USA

Date: February 01, 2016

Customer: John J. Barley  
Electronics Shop Supervisor  
Cornell University  
Lab for Elementary Particle Ph  
361 Synchrotron Dr.  
Ithaca, NY, 14853  
Email: jlb123@cornell.edu  
Ph: 607-255-4882

RFQ #: 020116-02  
REF: Ethernet Power Supply Contro

Dear John,  
BIRA Systems appreciates this opportunity to

Model	Qty
Ethernet Power Supply Controller (EPSC)	
1234	
5432-21	
0234	

BIRA Systems Inc. payment terms are NET 30  
if there is anything else we can help you with

Sincerely,  
BIRA Systems Inc.  
E-mail: quotes@bira.com

**BIRA**

2410 Midtown Pl  
Albuquerque, NM  
87107 USA

Date: February 01, 2016

Customer: John J. Barley  
Electronics Shop Supervisor  
Cornell University  
Lab for Elementary Particle Ph  
361 Synchrotron Dr.  
Ithaca, NY, 14853  
Email: jlb123@cornell.edu  
Ph: 607-255-4882

RFQ #: 020116-02  
REF: MCOR System Budgetary

Dear John,  
BIRA Systems appreciates this opportunity to

Model	Qty
MCOR Power Modules	
2310	
MCOR Cables	
2310	
MCOR Cooling Unit	
4022	
MCOR Cables	
2307	
2308	

NOTE: At this time quote does not reflect

BIRA Systems Inc. payment terms are NET 30  
if there is anything else we can help you with

Sincerely,  
BIRA Systems Inc.  
E-mail: quotes@bira.com

**BIRA**

2410 Midtown Pl  
Albuquerque, NM  
87107 USA

Date: February 02, 2016

Customer: John J. Barley  
Electronics Shop Supervisor  
Cornell University  
Lab for Elementary Particle Ph  
361 Synchrotron Dr.  
Ithaca, NY, 14853  
Email: jlb123@cornell.edu  
Ph: 607-255-4882

RFQ #: 020116-02  
REF: MCOR 30 Power Module Bud

Dear John,  
BIRA Systems appreciates this opportunity to

Model	Qty
MCOR Power Modules	
2310	
Optional Items	
2302	
4022	
2307	
2308	

NOTE: Ethernet MCOR Controller is not incl

BIRA Systems Inc. payment terms are NET 30  
if there is anything else we can help you with

Sincerely,  
BIRA Systems Inc.  
E-mail: quotes@bira.com

**CAENels**  
Gear For Science

CAEN Technologies, Inc.

Our Reference: QUD116843      **QUOTATION**      Date of Quotation: May 3, 2016

From: CAEN Technologies Inc.  
1140 Bay Street - 2C  
Staten Island, NY 10305

To: Cornell University  
Lab for Elementary Particle Physics  
161 Synchrotron Dr.  
Ithaca, NY 14850  
USA

Phone: (718) 981-0401  
Email: caenels@caenelstechnologies.com

Attn: John Barley

Item	Product code	Description	U. P.	Qty.	Disc. %	Subtot.
1	-	EASY-DRIVER 1000 - Digital Bipolar Current Power Supply 1x15A@±20V - 2000W - 15% discount quantity	\$ 3,250.00	250.00	15.00	\$ 692,625.00
2	-	FAST-PS 1926-200 - Fast Connector Current and Voltage-Controlled Digital Power Supply ±15A@±20V (200W max) - 15% discount quantity	\$ 5,016.00	250.00	15.00	\$ 1,068,900.00
<b>Total</b>						<b>\$ 1,756,525.00</b>

- quote for budgetary purposes  
- reference email from John Barley titled "easy driver"  
- discounts more accurately adjusted based on ship schedules, exchange rates, etc.

**Notice: PLEASE MAKE PURCHASE ORDER OUT TO:**  
CAEN TECHNOLOGIES INC.  
1140 Bay Street - 2C  
Staten Island, NY 10305  
via email (recommended): caenels@caenelstechnologies.com  
via fax: (718) 556-9183  
ATTN: Denise Haron or Adriana Romano - Phone: (718) 981-0401  
In case of order please mention the product code.

**Prices:** FOB Staten Island, New York  
**Delivery:** See above  
**Quotation validity:** 4 weeks from present  
**Guarantee:** 1 year at Staten Island, New York  
**Payment:** 30 days from invoice date  
**Shipping:** Please provide preferred method ("pre-pay and add" or "ship on account w/ acct. number") and service.

Thank you for the opportunity to quote this requirement. Feel free to contact me should you require any more information.

1140 Bay Street 2C - Staten Island, NY 10305  
Phone +1 718 981 0401 - Fax +1 718 556 9183  
info@caenelstechnologies.com - www.caenelstechnologies.com

Page 1 of 2

Very Preliminary – L2 leaders currently vetting our early schedules based on current designs and expectations

ID	Task Name	Duration	Start	Finish	2017	2018	2019	2020	2021							
					Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0	<b>Cbeta Project</b>	095 days	Mon 2/29/10	Fri 5/8/20	[Gantt bar]											
1	<b>Project Management</b>	095 days	Mon 2/29/10	Fri 5/8/20	[Gantt bar]											
2	Milestone: project start	0 days	Mon 2/29/10	Mon 2/29/10	◆ 2/29											
3	Conceptual Design Report	60 days	Mon 2/29/10	Fri 5/20/16	[Gantt bar: Mayes, Dobbins, BartnikA[25%], Crittenden[25%], RA-02 TBH[25%], RA-03 TBH[25%], Quigley[25%]]											
4	General Administrative Items	095 days	Mon 2/29/10	Fri 5/8/20	[Gantt bar: Brangan[5%], DeFalco[5%]]											
5	Project Management	095 days	Mon 2/29/10	Fri 5/8/20	[Gantt bar: Dunham, Gallagher[25%], ...]											
6	Milestone: Project end	0 days	Fri 12/27/19	Fri 12/27/19	◆ 12/27											
7	<b>Physics Support</b>	580 days	Mon 2/29/10	Fri 5/18/18	[Gantt bar]											
8	Space Charge Simulations	130 days	Mon 8/15/10	Fri 2/10/17	[Gantt bar: Mayes, Gulliford[50%], RA-02 TBH[50%], RA-03 TBH[50%], BartnikA[33%]]											
9	Beam Optics	130 days	Mon 2/13/17	Fri 8/11/17	[Gantt bar: Mayes, Gulliford[50%], RA-02 TBH[50%], Crittenden[25%], RA-03 TBH, BartnikA[33%]]											
10	Collective Effects	130 days	Mon 8/14/17	Fri 2/9/18	[Gantt bar: Mayes, Gulliford[75%], RA-02 TBH[50%], Crittenden[25%], RA-01 TBH[25%], BartnikA[50%], FA-03 TBH]											
11	Front to End Simulations	130 days	Mon 2/12/18	Fri 8/10/18	[Gantt bar: Mayes[80%], Gulliford[72%], RA-02 TBH[40%], Crittenden[40%], RA-01 TBH[20%], BartnikA[40%], Do]											
12	Machine Database	520 days	Wed 6/22/10	Wed 6/20/18	[Gantt bar: RA-01 TBH[66%], Crittenden[10%], Dobbins[0%]]											
13	Milestone: Simulations complete	0 days	Fri 8/10/18	Fri 8/10/18	◆ 8/10											
14	<b>Injector</b>	60 days	Fri 5/20/10	Fri 8/12/10	[Gantt bar]											
15	Laser	60 days	Mon 5/23/10	Fri 8/12/10	[Gantt bar: RA-03 TBH[10%]]											
16	Cathodes	60 days	Mon 5/23/10	Fri 8/12/10	[Gantt bar: Cultrera[10%]]											
17	Mirror-merger section (placeholder TBD)	0 days	Fri 5/20/10	Fri 5/20/10	◆ 5/20											
18	Milestone: Injector Ready	0 days	Fri 8/12/10	Fri 8/12/10	◆ 8/12											
19	<b>Linac</b>	485 days	Mon 2/29/10	Fri 1/5/18	[Gantt bar]											
20	<b>RF Amplifiers</b>	385 days	Mon 5/23/10	Fri 11/10/17	[Gantt bar]											
21	Procure Amplifiers and components	200 days	Mon 5/23/10	Fri 2/24/17	[Gantt bar: Quigley[1%]]											
22	Design/Layout In Test Area	40 days	Mon 2/27/17	Fri 4/21/17	[Gantt bar: Quigley, Hartman[25%]]											
23	7 Solid Stae Amplifiers (SSA) Installation	20 days	Mon 4/24/17	Fri 5/19/17	[Gantt bar: Quigley[50%], Mech-Tech Newman[200%], MillerK[10%], Maywright[25%], Mech-Tech Wilson]											

- Risk Analysis at the L2 Technical level by the L2 Leaders
- Global Risk Analysis by the PI / PM team

Modeled after the Atlas Upgrade Risk Registry and similar to what Cornell has done for the US CMS Upgrade.

Accelerator physics systems level risk analysis by outside expert – Dave Douglas

## Cornell-Brookhaven CBETA Risk Form

**Risk Identifier:** \_\_\_\_\_ **Risk Owner:** Smolenski

**Risk ID:** PM-00X **Risk Type:** Threat

**Date:** Month XX, 2016 **Date revised:** Month XX, 2016

- I. **Risk Title:** ADD YOUR TITLE HERE
- II. **Risk Description:** ADD YOUR DESCRIPTION HERE
- III. **Detailed Risk Cause:** ADD YOUR RISK CAUSE HERE
- IV. **Detailed Risk Effect:** ADD YOUR RISK EFFECT HERE
- V. **Risk Analysis:** ADD YOUR RISK ANALYSIS HERE
- VI. **Mitigation Plan or Risk Mitigation Measures:**

Overall Mitigation: ADD YOUR TEXT HERE

Residual Risk: ADD YOUR TEXT HERE

## Work Breakdown Structure (Level 2)

1.1	Project management:	Steve Peggs (BNL)
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1.3	DC electron source:	Karl Smolenski (CU)
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1.7	Power supplies:	John Barley (CU)
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1.11	Infrastructure:	Rich Gallagher (CU)
1.12	Commissioning:	Adam Bartnik (CU)
1.13	Safety:	Brian Heltsley (CU)



All magnets / girders drive the budget and schedule

Dividing the work among the team

- Splitter / Combiner mechanical design at Cornell
- Commercial partners for conventional Magnets
- Arc Girder(s) designed at BNL

Multiple solutions to the Hybrid Magnets:

In house production at SMD or C-AD (BNL developing cost / schedule projections)

Outside vendors / partnerships at a variety of levels (from components to system)  
– Cornell to issue Budgetary RFP

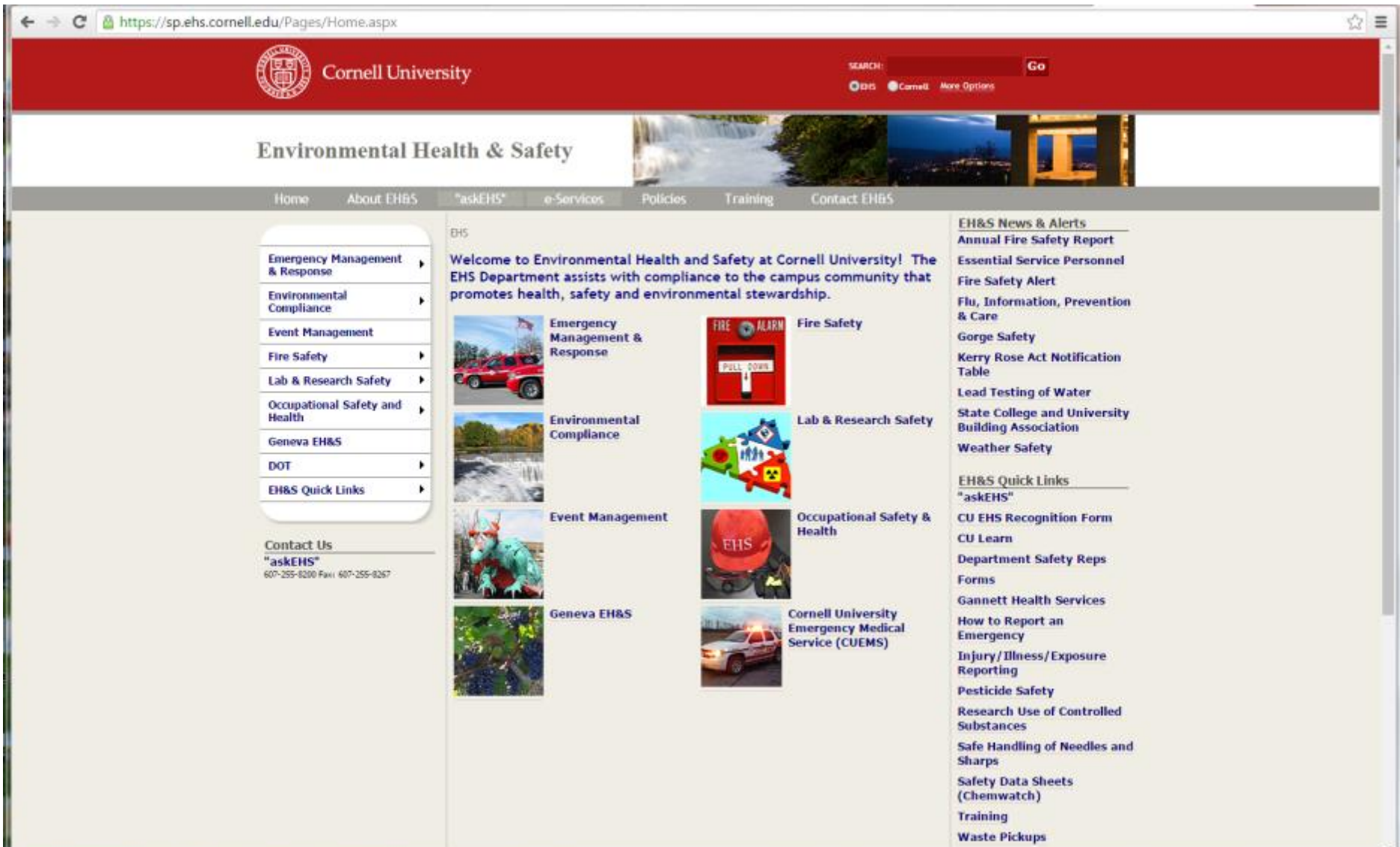
- Danfysik
- Kyma
- Sigma Phi
- NeoMax (?)

*Two following talks will go into greater detail*

Work at BNL follows BNL Safety policies

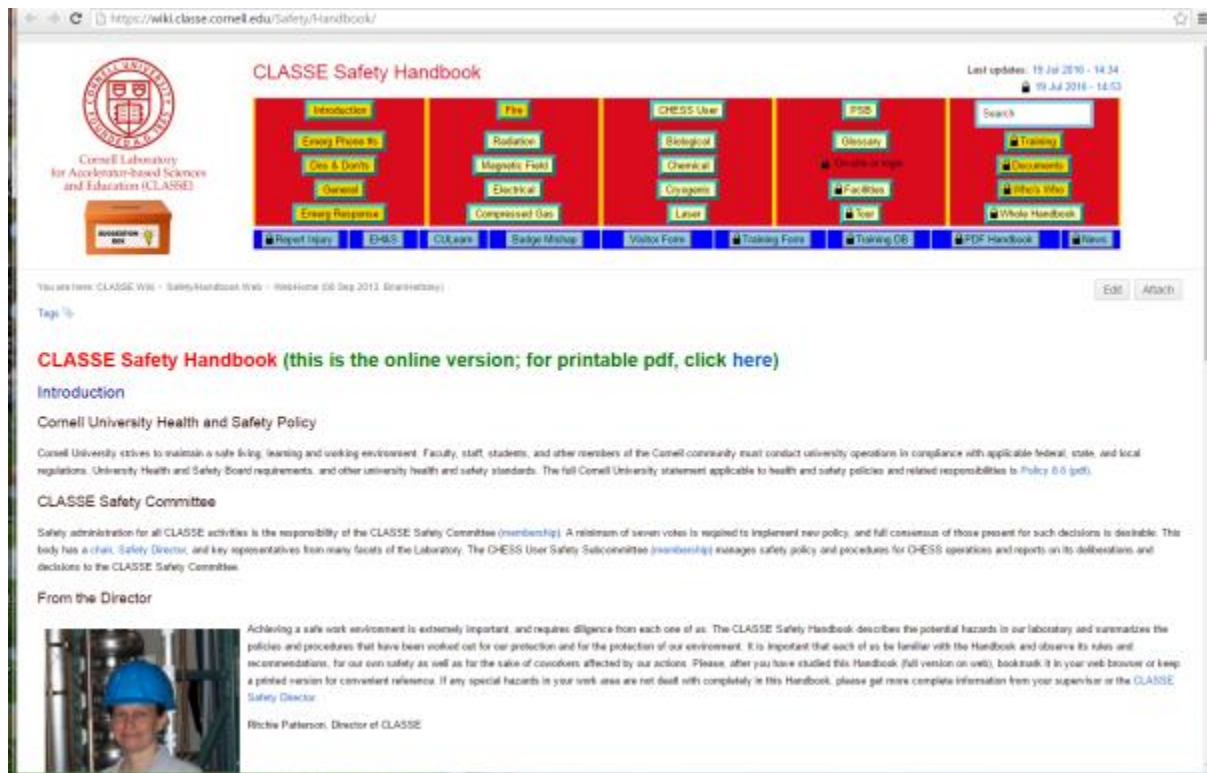
Work at Cornell follows Cornell University Safety policies

Both Labs have similar and well established cultures of safety. Cornell has dedicated safety staff at the **university level** and within the laboratory.



The screenshot shows the Cornell University Environmental Health & Safety (EH&S) website. The page features a red header with the Cornell University logo and a search bar. Below the header is a navigation menu with links for Home, About EH&S, "askEHS", e-Services, Policies, Training, and Contact EH&S. The main content area is divided into three columns. The left column contains a list of services: Emergency Management & Response, Environmental Compliance, Event Management, Fire Safety, Lab & Research Safety, Occupational Safety and Health, Geneva EH&S, DOT, and EH&S Quick Links. The middle column contains a welcome message and several service tiles: Emergency Management & Response (with a red fire truck image), Environmental Compliance (with a waterfall image), Event Management (with a green dragon image), and Geneva EH&S (with a green dragon image). The right column contains a list of news and alerts, including Annual Fire Safety Report, Essential Service Personnel, Fire Safety Alert, Flu, Information, Prevention & Care, Gorge Safety, Kerry Rose Act Notification Table, Lead Testing of Water, State College and University Building Association, and Weather Safety. Below the news and alerts is a section for EH&S Quick Links, including "askEHS", CU EHS Recognition Form, CU Learn, Department Safety Reps Forms, Gannett Health Services, How to Report an Emergency, Injury/Illness/Exposure Reporting, Pesticide Safety, Research Use of Controlled Substances, Safe Handling of Needles and Sharps, Safety Data Sheets (Chemwatch), Training, and Waste Pickups.

- Both Labs have similar and well established cultures of safety. Cornell has dedicated safety staff at the **university level** and within the laboratory.
- CLASSE has on-site Safety Director (Brian Heltsley) at the level of the Oversight Committee and a Radiation Safety Specialist.
- All staff have “Stop Work” Authority



The screenshot shows a web browser displaying the Cornell University CLASSE Safety Handbook. The page features a navigation menu with categories such as Introduction, Fire, CHESS User, PFD, and Search. Below the menu, there is a section titled "CLASSE Safety Handbook (this is the online version; for printable pdf, click here)" and an "Introduction" section. The introduction text discusses Cornell University's commitment to safety and the role of the CLASSE Safety Committee. A photo of Rickie Patterson, Director of CLASSE, is included at the bottom of the introduction.

- As a user facility, CLASSE has an established policy and training program for visiting (short term) scientists.
- With a lengthy experimental program we expect that many BNL CBETA members will take part in our staff-level in-person general laboratory and radiation safety training.

Forming a cohesive team and successful partnership

Better video conferencing for weekly meetings Web-Ex to Zoom (soon, Cornell IT)

- Tuesday 10am L2 Technical Meetings (Karl Smolenski Organized)
- Thursday 4pm Physics Meetings (Stephen Brooks Organized)
- L2 Magnet meeting (Holger Witte Organized)

Cloud based file storage, WBS based, ([cornell.box.com](http://cornell.box.com)) for shared computing

Open need for engineering drawing repository (Cornell Vault Cloud). Need to work with BNL to establish a joint cloud based native file storage site or integrate BNL into our current one (Autodesk Vault). We think we can handle BNL native formats on our end.

Frequent in-person collaboration meetings at Cornell and BNL

Final Year dedicated to commissioning

How to get BNL staff involved at Cornell earlier?

- BPM tests with injector
- Specified training sessions during early (Pre-MLC) commissioning of LINAC
- Fractional Arc Tests using a minimal set of FFAG magnets

Likewise Cornell staff needs to be closely involved with magnet developments at BNL

- Karl and Yulin as key players with Hybrid PM Magnets
- David Burke as key player for spreader section

Thank you!



