Project X Siting Workshop Overview

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Project X Siting Workshop
04-Oct-2012

Workshop Objective

- Produce a site layout for use in the Project X Reference Design Report that is compatible with a staged approach and accommodates the planned suite of experiments. The layout should minimize costs, especially in Stage 1, yet maintain performance requirements and provide a logical path for proceeding through all stages.

- Objective is to converge on a single option, minimum success threshold is to identify short list of follow ups and path toward rapid conclusion.

- Out-of-the-box ideas are welcome, but we really do need to converge.
- **Decision will be based on incomplete information**

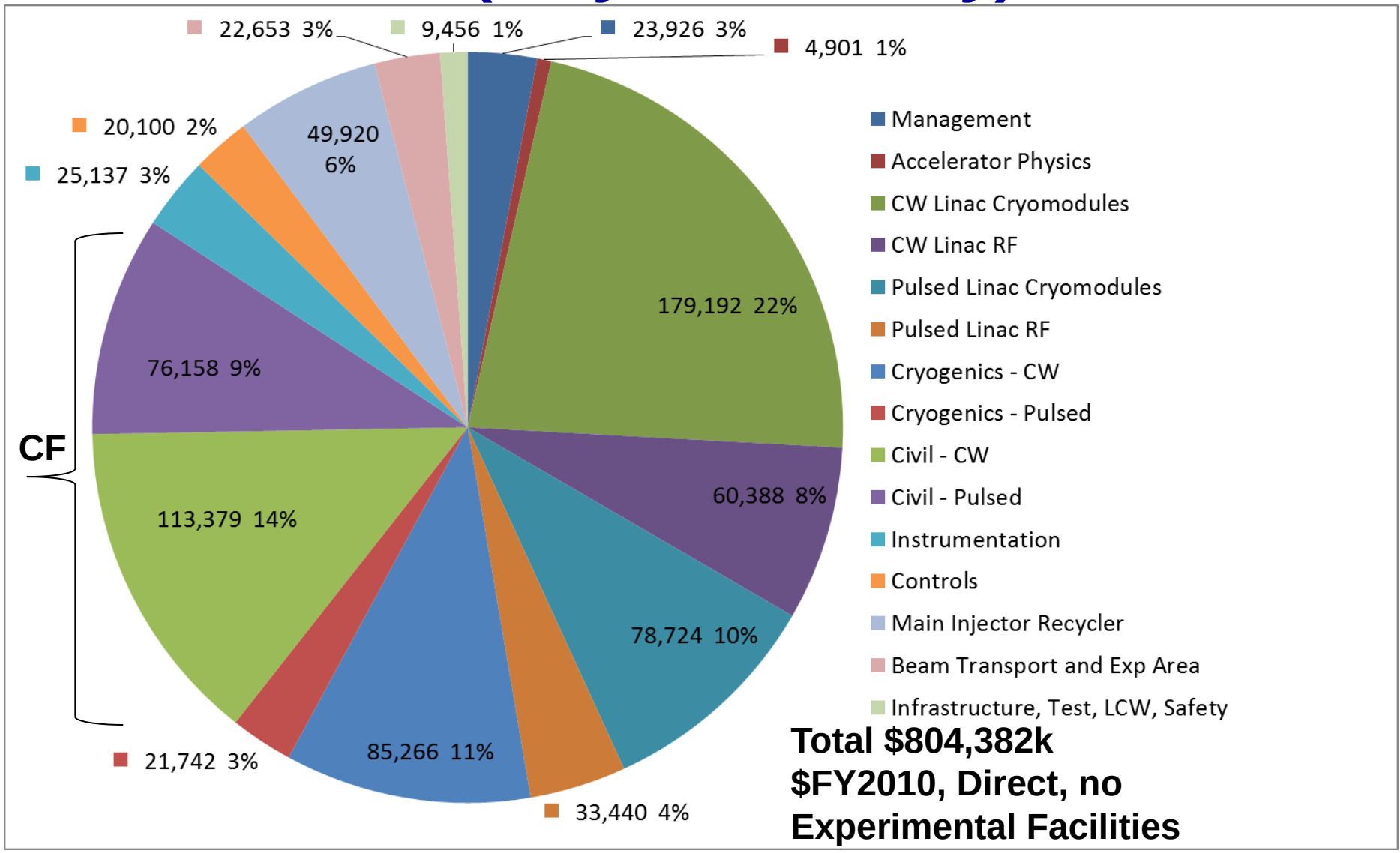
Workshop Agenda

1. Overview and Current Status (15 min) – M. Kaducak
2. Experimental Program (15 min) – R. Tschirhart
3. MI/RR and Transfer Lines (15 min) – D. Johnson
4. Booster (15 min) – R. Zwaska
5. 180 deg. Arc Feasibility – V. Lebedev (15 min)
6. Conventional Facilities (15 min) – R. Alber
7. Discussion (45 min) - All
8. Wrapup (15 min) – M. Kaducak

Siting Considerations
(no particular order of priority)

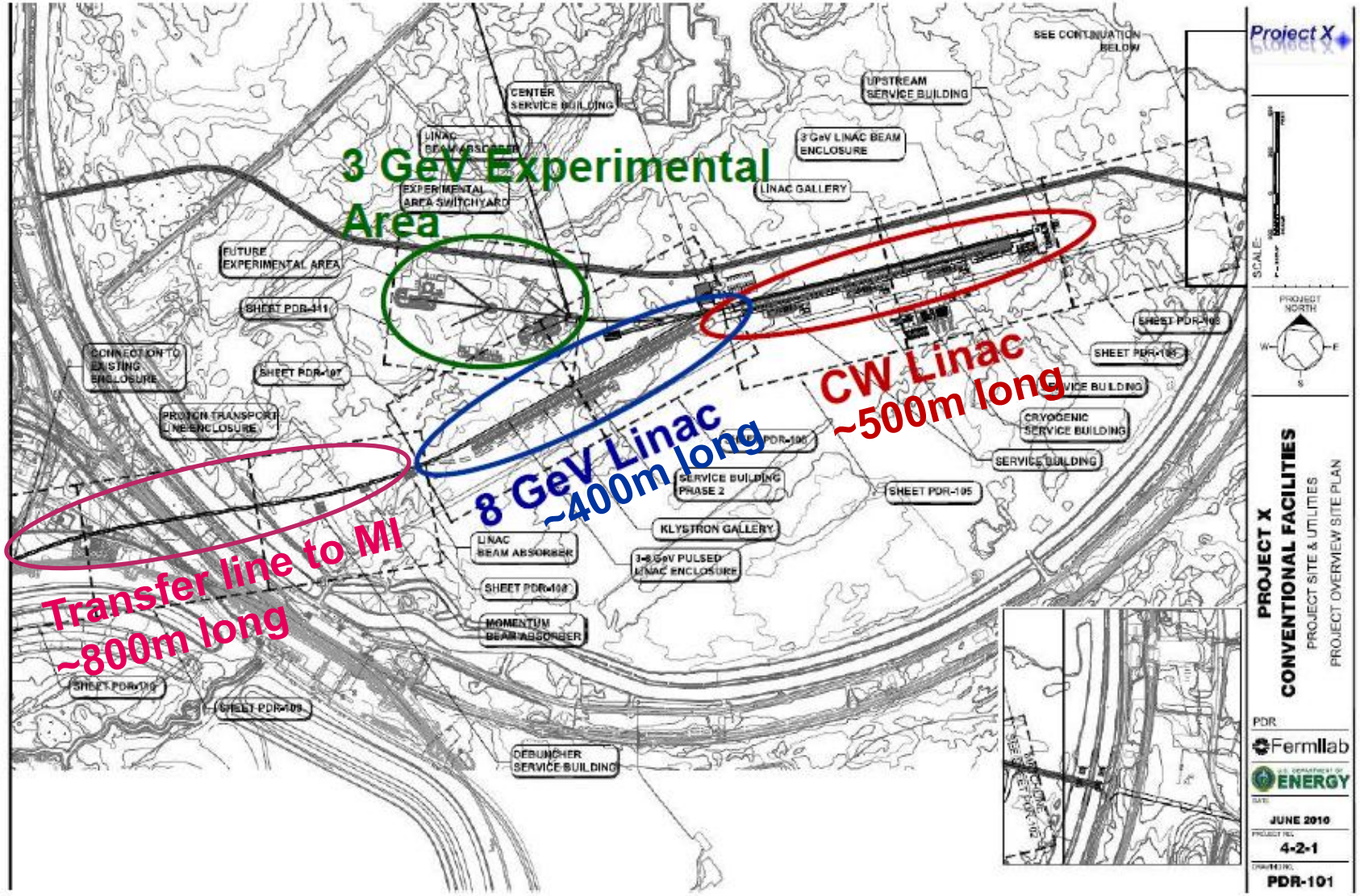
- Functionality
- Effects on Operating Programs
- Compatibility with Planned Programs (e.g. Muon Campus, LBNE)
- Upgradeability/Expandability
- Maintainability
- Cost (total system and life cycle)
- Schedule
- Aesthetics
- Environmental Impact

Full Project X Costs (Very Preliminary)

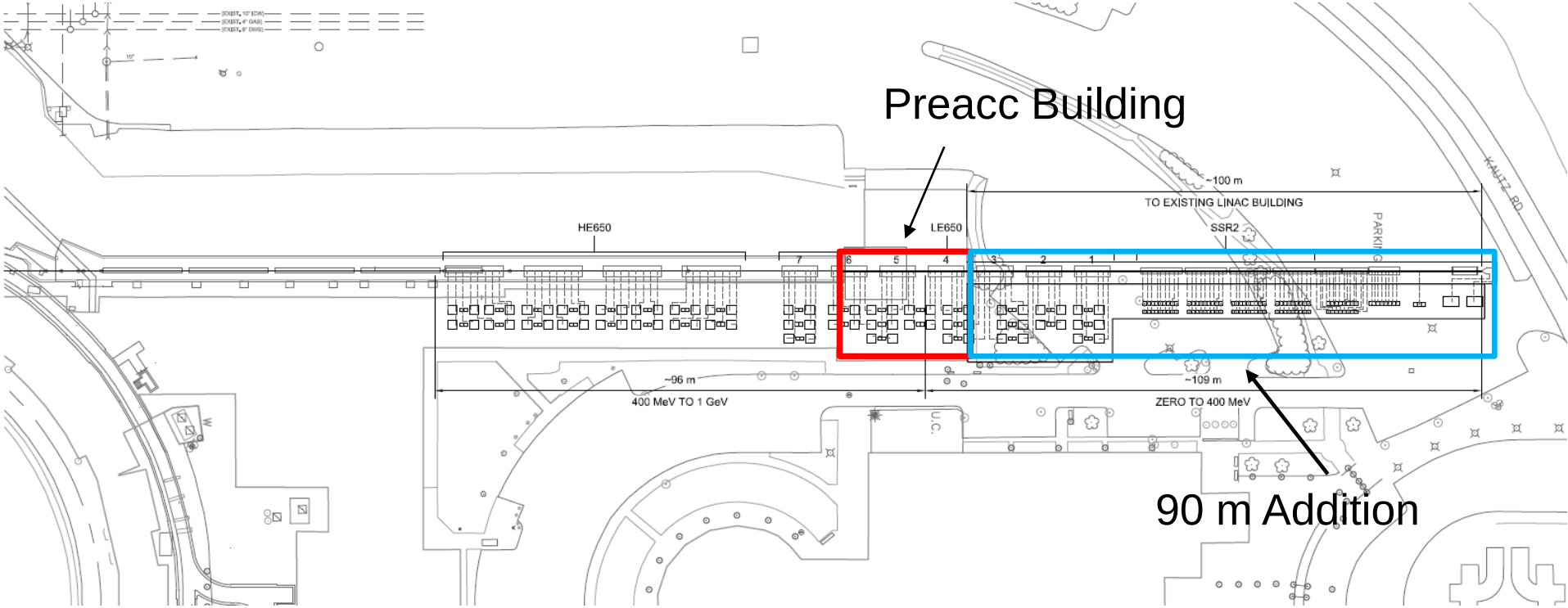


Total $804,382k
$FY2010, Direct, no Experimental Facilities

One Shot 2010 "Reference Design"



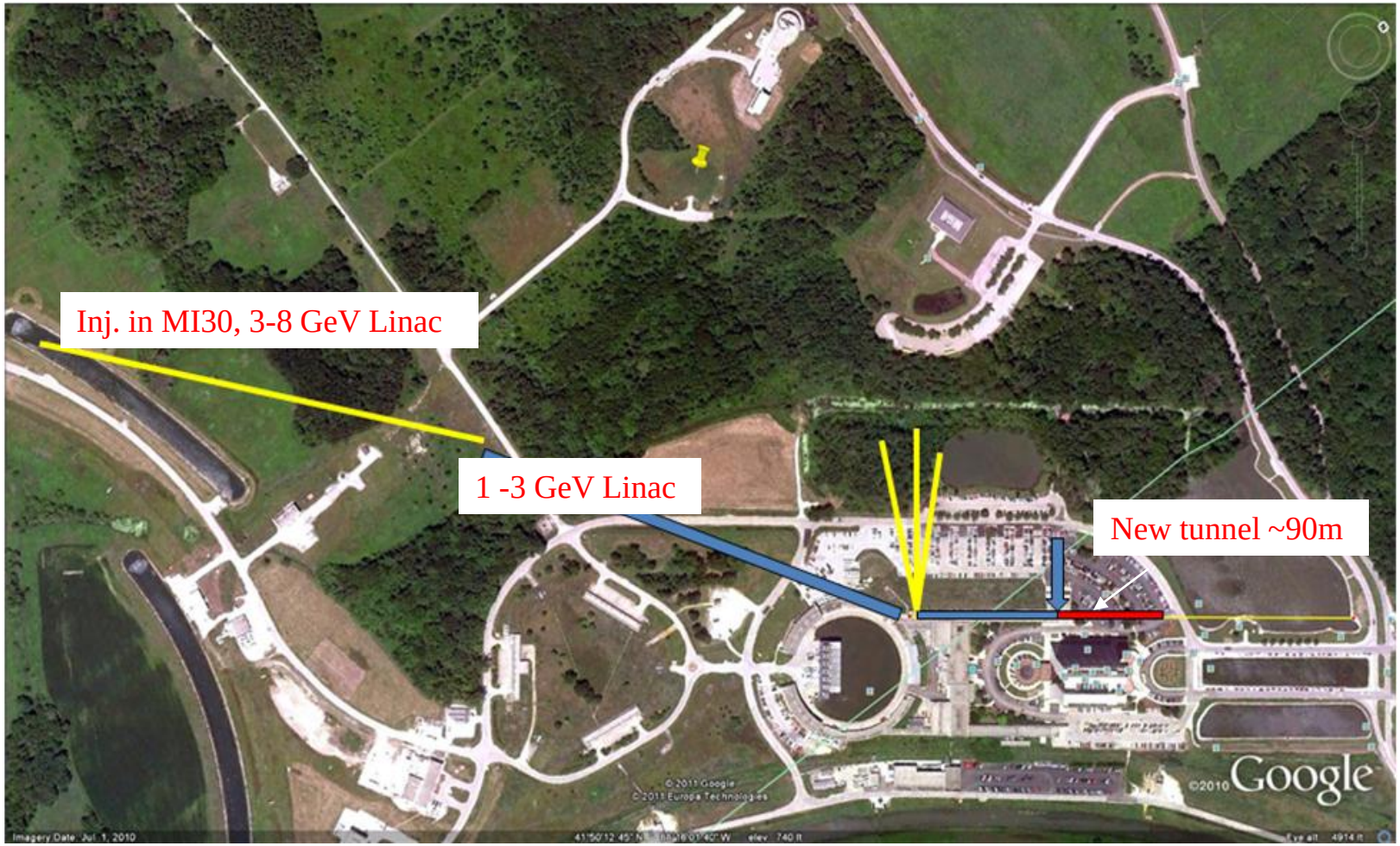
Stage 1 Linac – Use of existing Linac space



- Build new ~400 MeV linac in new+Preacc enclosure
- Build a transfer line along present linac and inject in Booster
- Decommission the existing linac and extend new linac up to ~1 GeV in existing tunnels and galleries
- Add a Storage Ring in the Booster tunnel

Slide from M. Popovic

Add 90 m to the existing Linac tunnel at the Low Energy End



Slide from M. Popovic

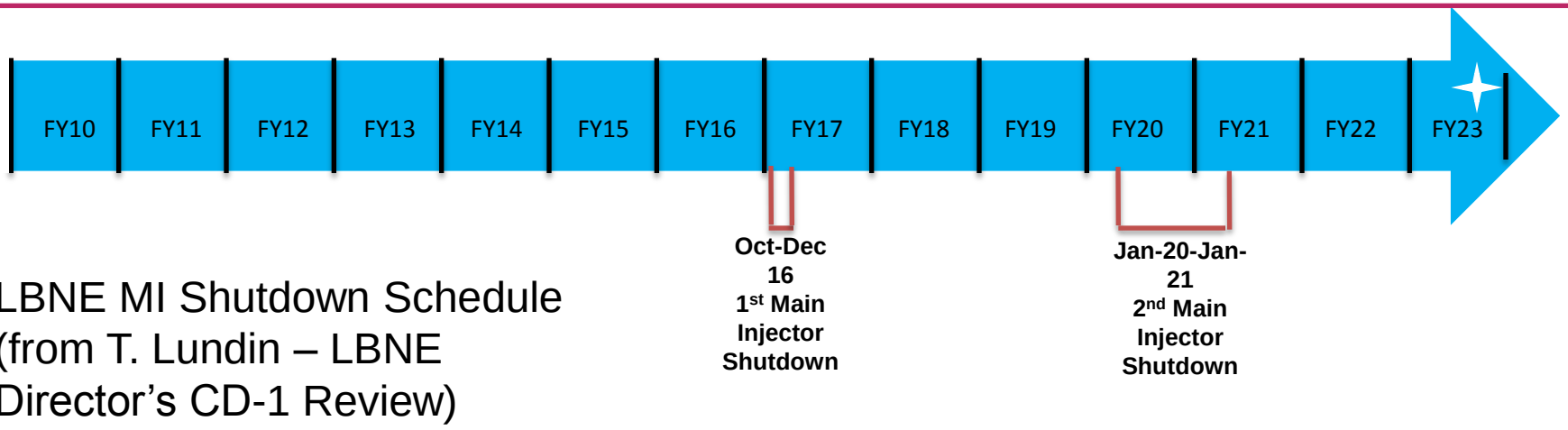
Planned Shutdowns

Draft 2012-15 Fermilab Accelerator Experiments' Run Schedule

Typically Revised Annually - This Version from January, 2012

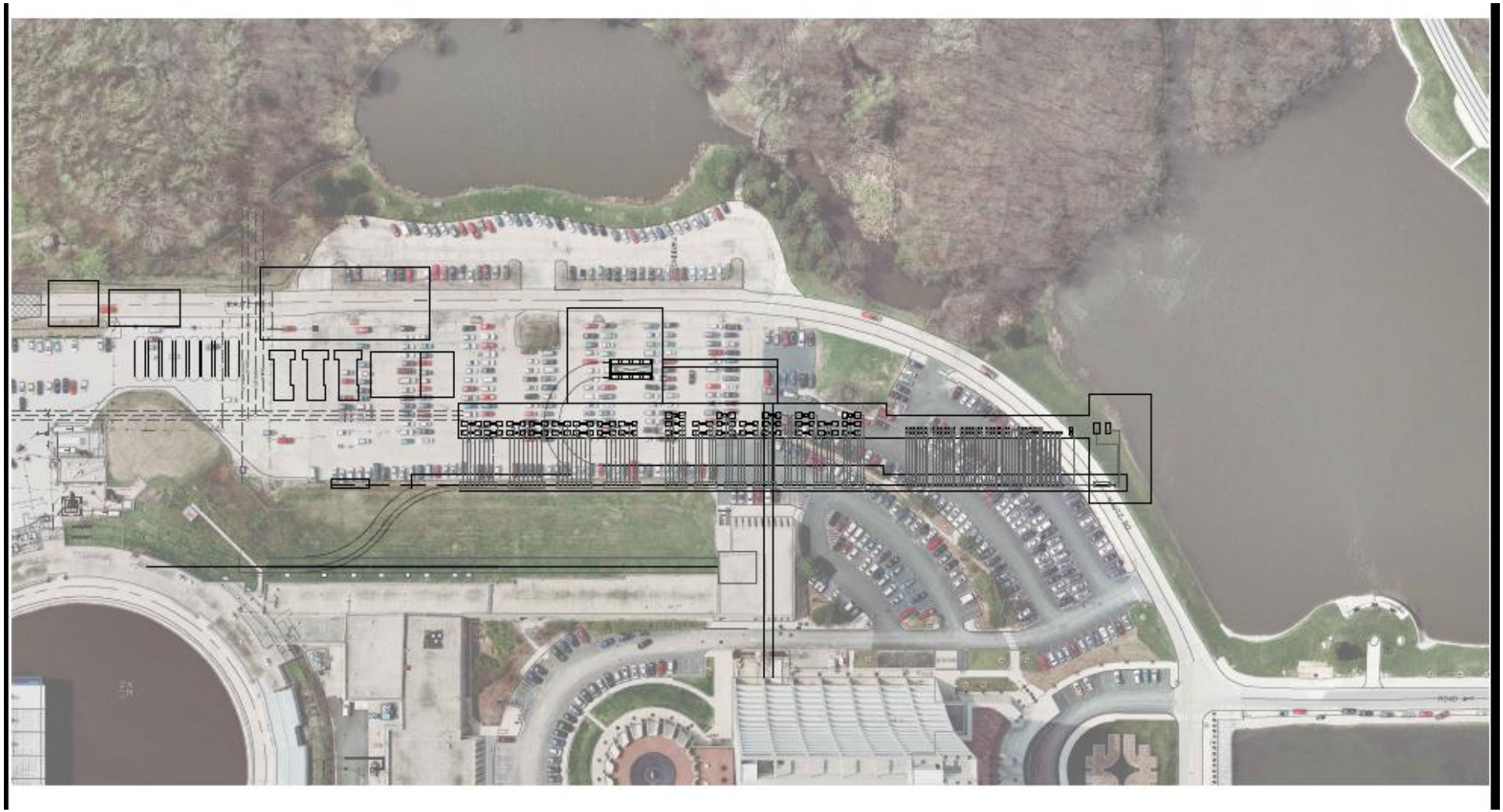
Calendar Year		2012	2013	2014	2015
Neutrino Program	B	MiniBooNE	OPEN	OPEN	OPEN
			MicroBooNE	MicroBooNE	MicroBooNE
Muons			g-2	g-2	g-2
Neutrino Program	MI	MINERvA	MINOS+	MINOS+	MINOS+
		MINOS	MINERvA	MINERvA	MINERvA
		NOvA	NOvA	NOvA	NOvA
SY 120	MT	Test Beam	Test Beam	Test Beam	Test Beam
	MC	OPEN	OPEN	OPEN	OPEN
	NM4	SeaQuest	E-906/SeaQuest	E-906/SeaQuest	OPEN

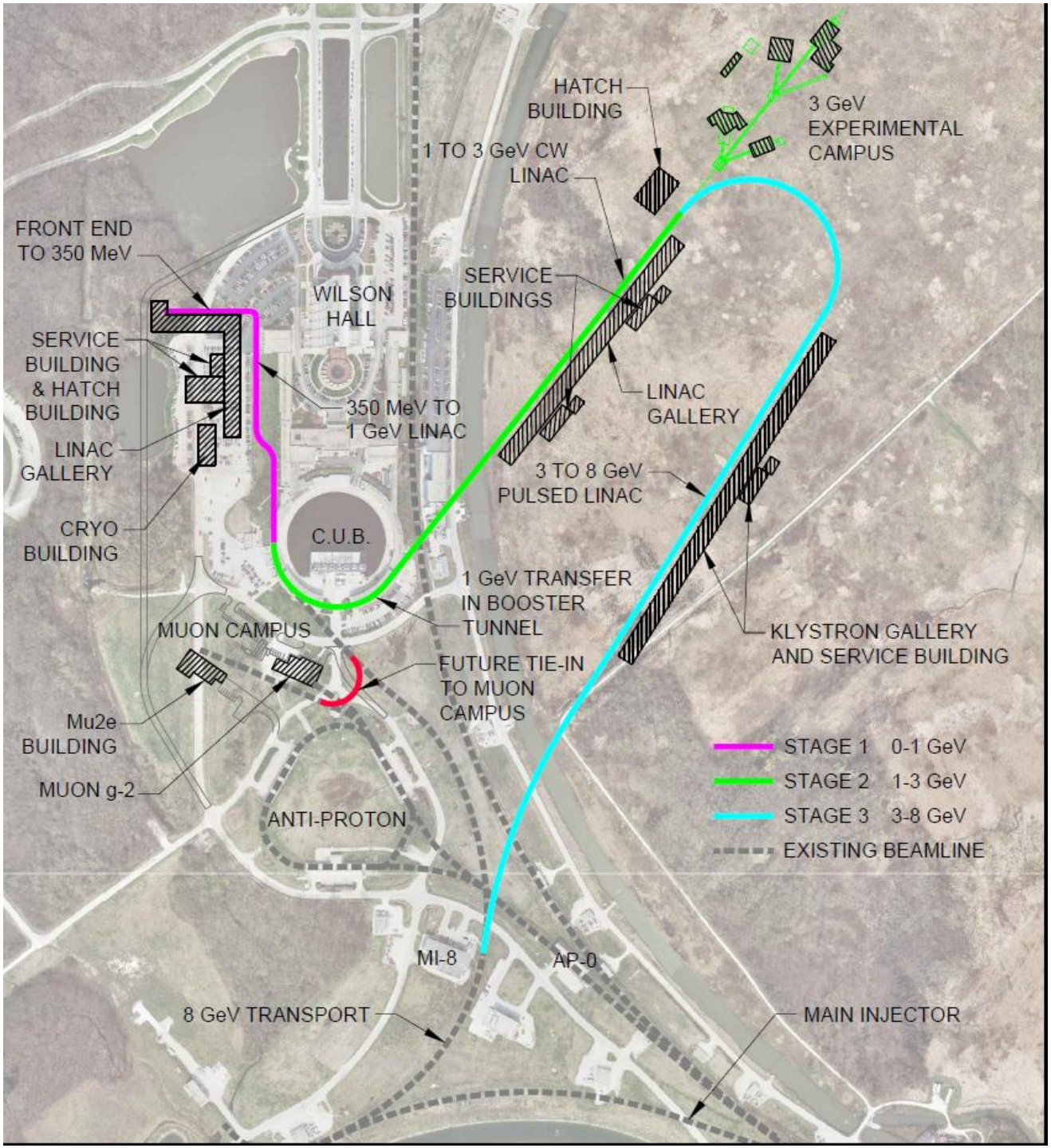
RUN/DATA
STARTUP/COMMISSIONING
INSTALLATION
M&D (SHUTDOWN)



LBNE MI Shutdown Schedule (from T. Lundin – LBNE Director's CD-1 Review)

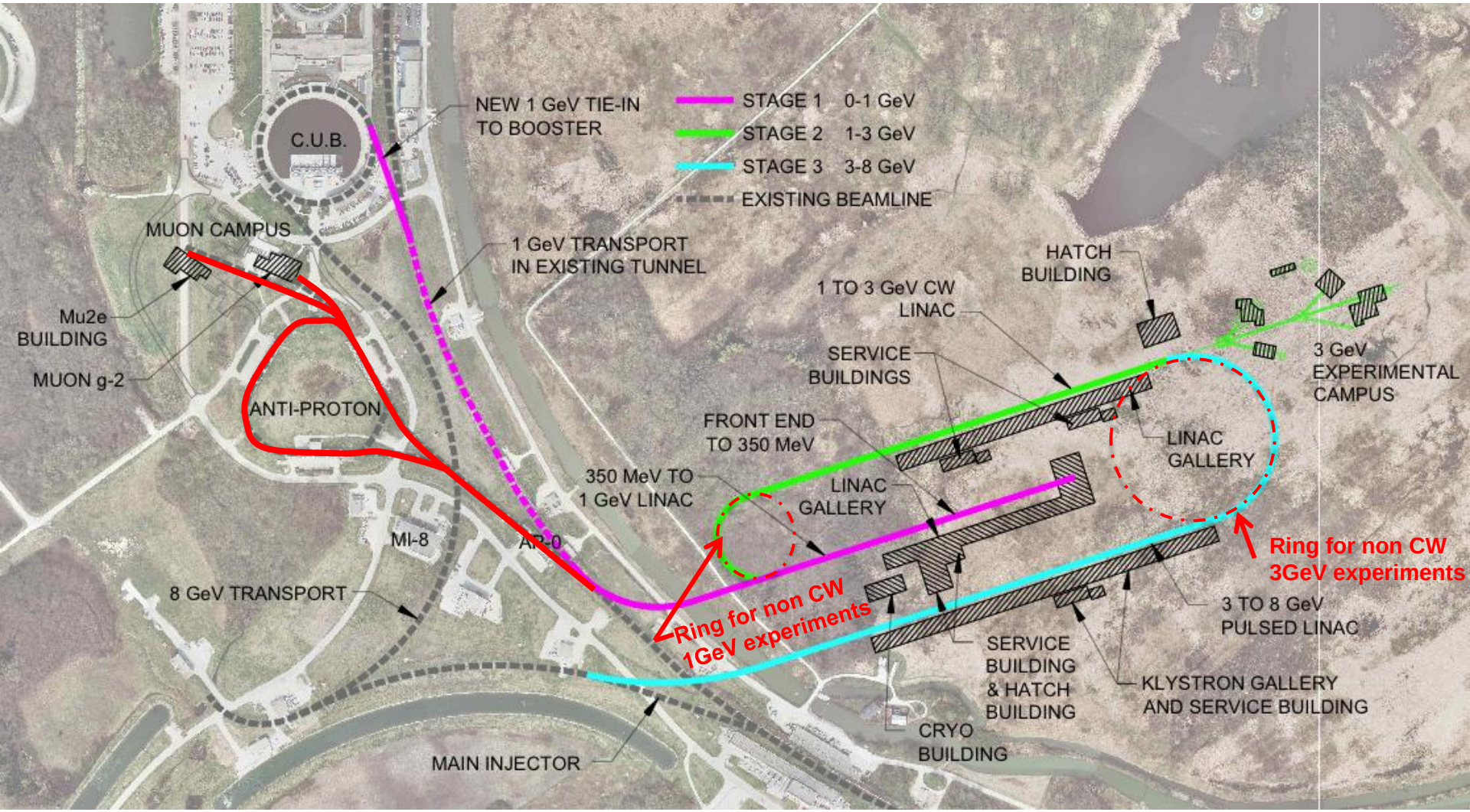
Stage 1 Linac - Straight in Parking Lot, Parallel to Exist.





Staged Layout – Parking Lot Linac

“Paperclip” Layout with Rings (C. Polly)



Stage 1: CW Linac (1 GeV, 1 mA) feeds Booster allowing 60-70% more beam at 8 and 120 GeV. 900 kW of CW beam remains at 1 GeV, and can be used in combination with existing AP0, former anti-proton rings, and new Muon Campus

Final Comments

- The “reference design” configuration has been fairly well detailed for a project at this stage.
- Configurations based on a staged approach are just now being developed. Time to pick one for the design report.
- Cost estimating for conventional facilities and machine hardware is mostly straightforward, but work for limited FTE.
- There will be cost pressure applied in the downward direction. Value Engineering to follow.

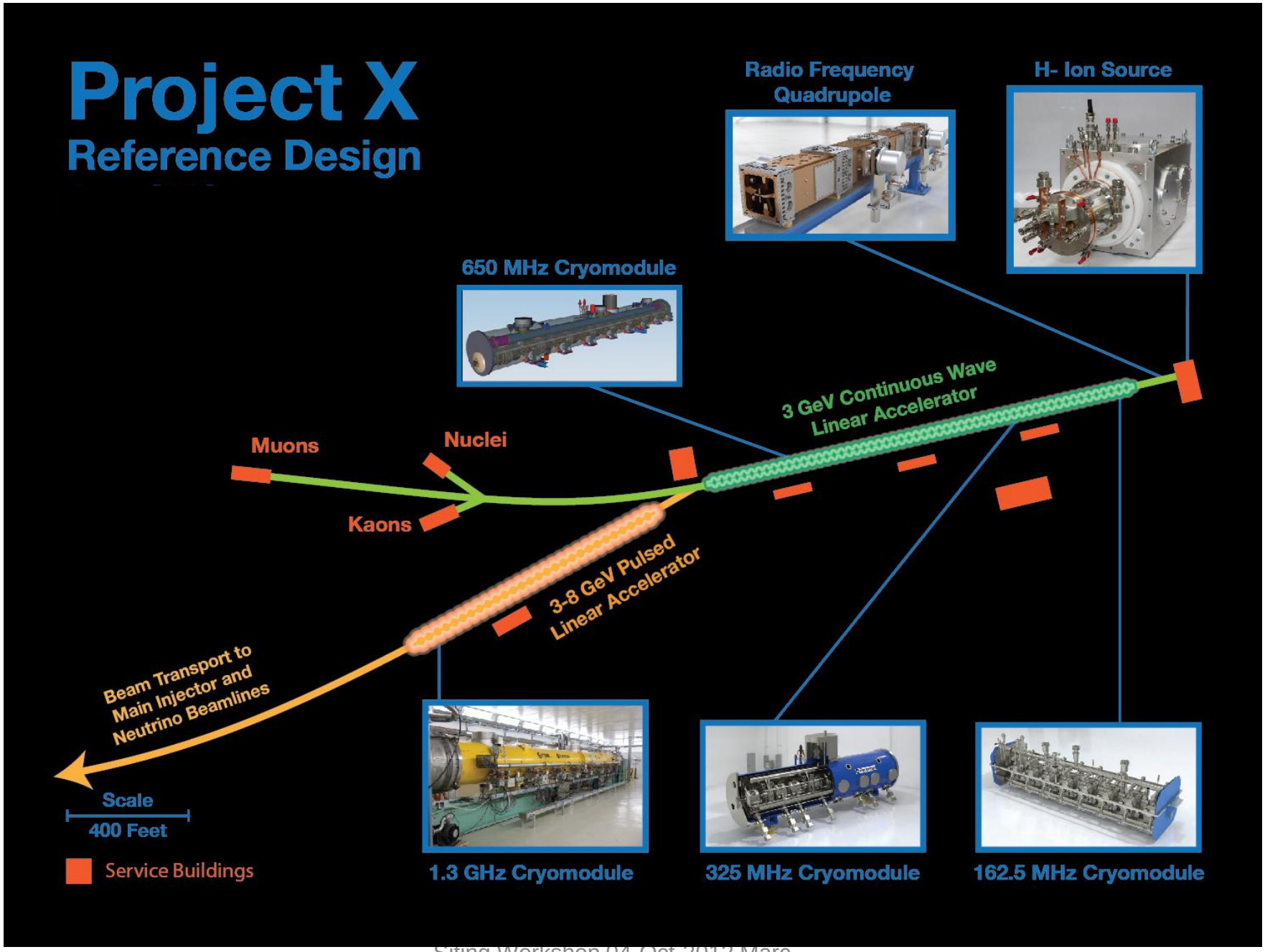
Thank you for your help

Example Power Staging Plan for the Research Program

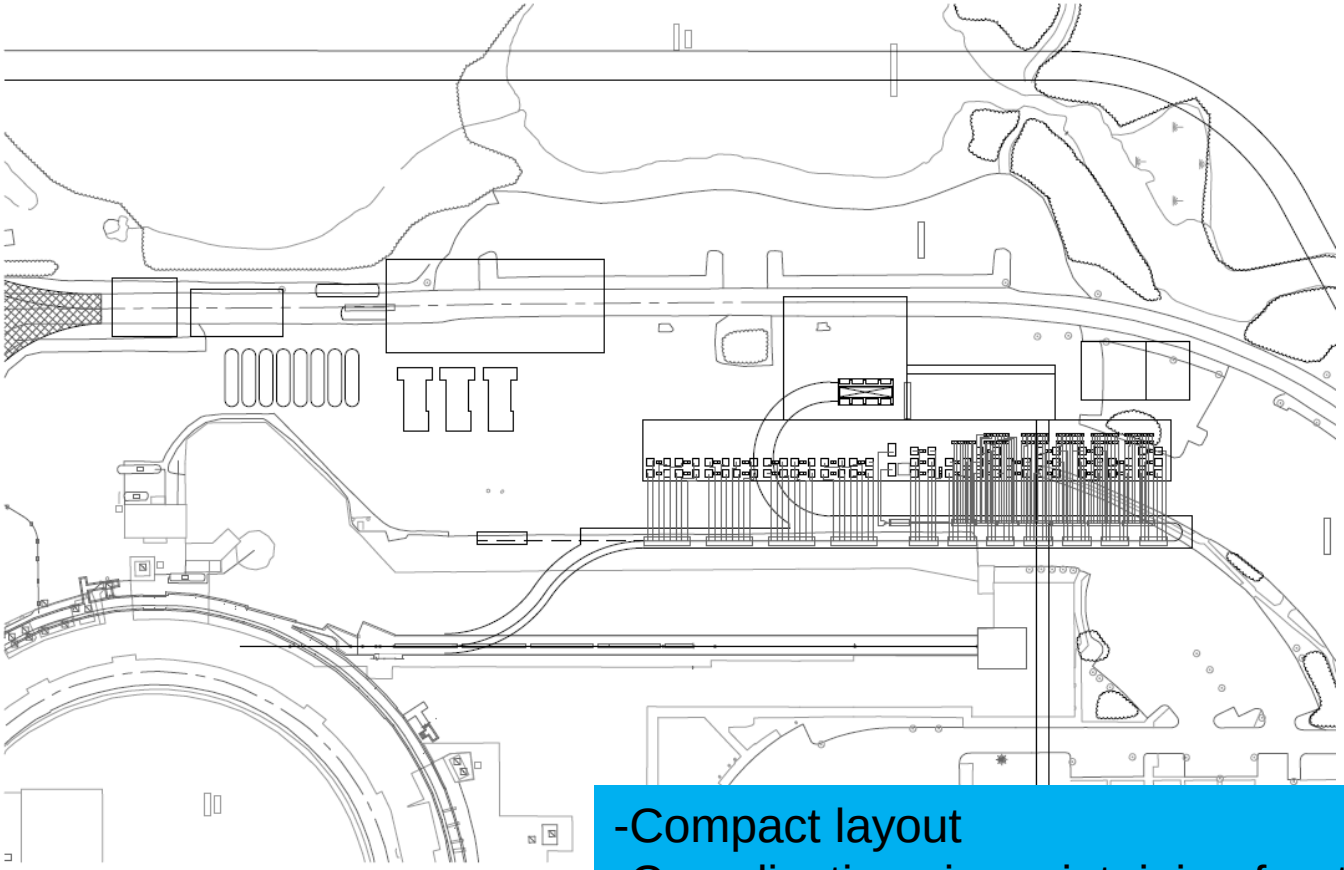
Program:	Onset of NOvA operations in 2013	Stage-1: 1 GeV CW Linac driving Booster & Muon, n/edm programs	Stage-2: Upgrade to 3 GeV CW Linac	Stage-3: Project X RDR	Stage-4: Beyond RDR: 8 GeV power upgrade to 4MW
MI neutrinos	470-700 kW**	515-1200 kW**	1200 kW	2450 kW	2450-4000 kW
8 GeV Neutrinos	15 kW + 0-50 kW**	0-42 kW* + 0-90 kW**	0-84 kW*	0-172 kW*	3000 kW
8 GeV Muon program e.g, (g-2), Mu2e-1	20 kW	0-20 kW*	0-20 kW*	0-172 kW*	1000 kW
1-3 GeV Muon program, e.g. Mu2e-2	-----	80 kW	1000 kW	1000 kW	1000 kW
Kaon Program	0-30 kW** (<30% df from MI)	0-75 kW** (<45% df from MI)	1100 kW		
Nuclear edm ISOL program	none	0-900 kW	0-900 kW		
Ultra-cold neutron program	none	0-900 kW	0-900 kW		
Nuclear technology applications	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
# Programs:	4	8	8	8	8
Total max power:	735 kW	2222 kW	4284 kW	6492 kW	11870kW

Priority is currently on design, costing of Stage 1 Linac and interfaces to experiments

* Operating point in range depends on MI energy for neutrinos.
** Operating point in range is depends on MI injector slow-spill duty factor (df) for kaon program.


Project X
Reference Design
Radio Frequency Quadrupole
H- Ion Source
650 MHz Cryomodule
3 GeV Continuous Wave Linear Accelerator
Muons
Nuclei
Kaons
3-8 GeV Pulsed Linear Accelerator
Beam Transport to Main Injector and Neutrino Beamlines
Scale
400 Feet
Service Buildings
1.3 GHz Cryomodule
325 MHz Cryomodule
162.5 MHz Cryomodule

Stage 1 Linac - Folded in Parking Lot



-Compact layout
-Complications in maintaining front end

Muon Campus Beam Configuration (from mu2e CDR)

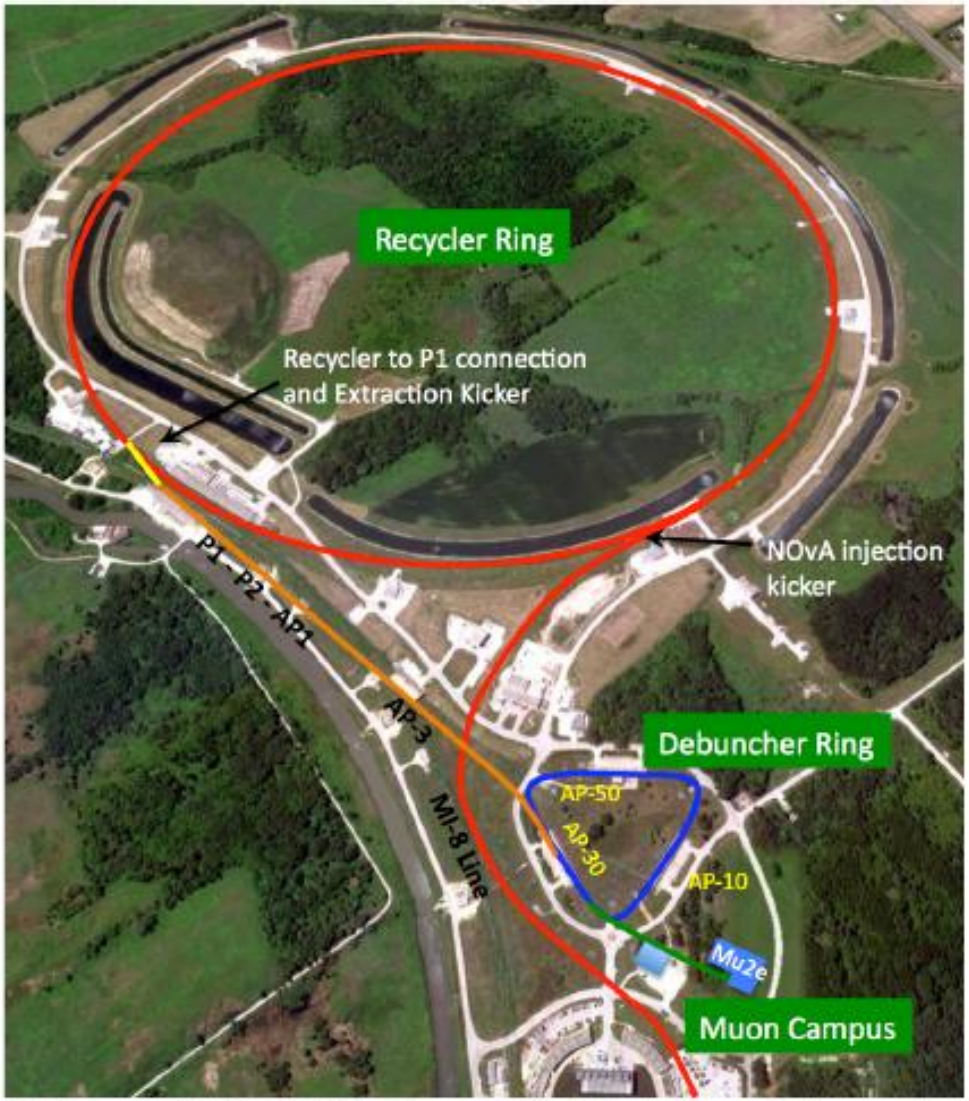
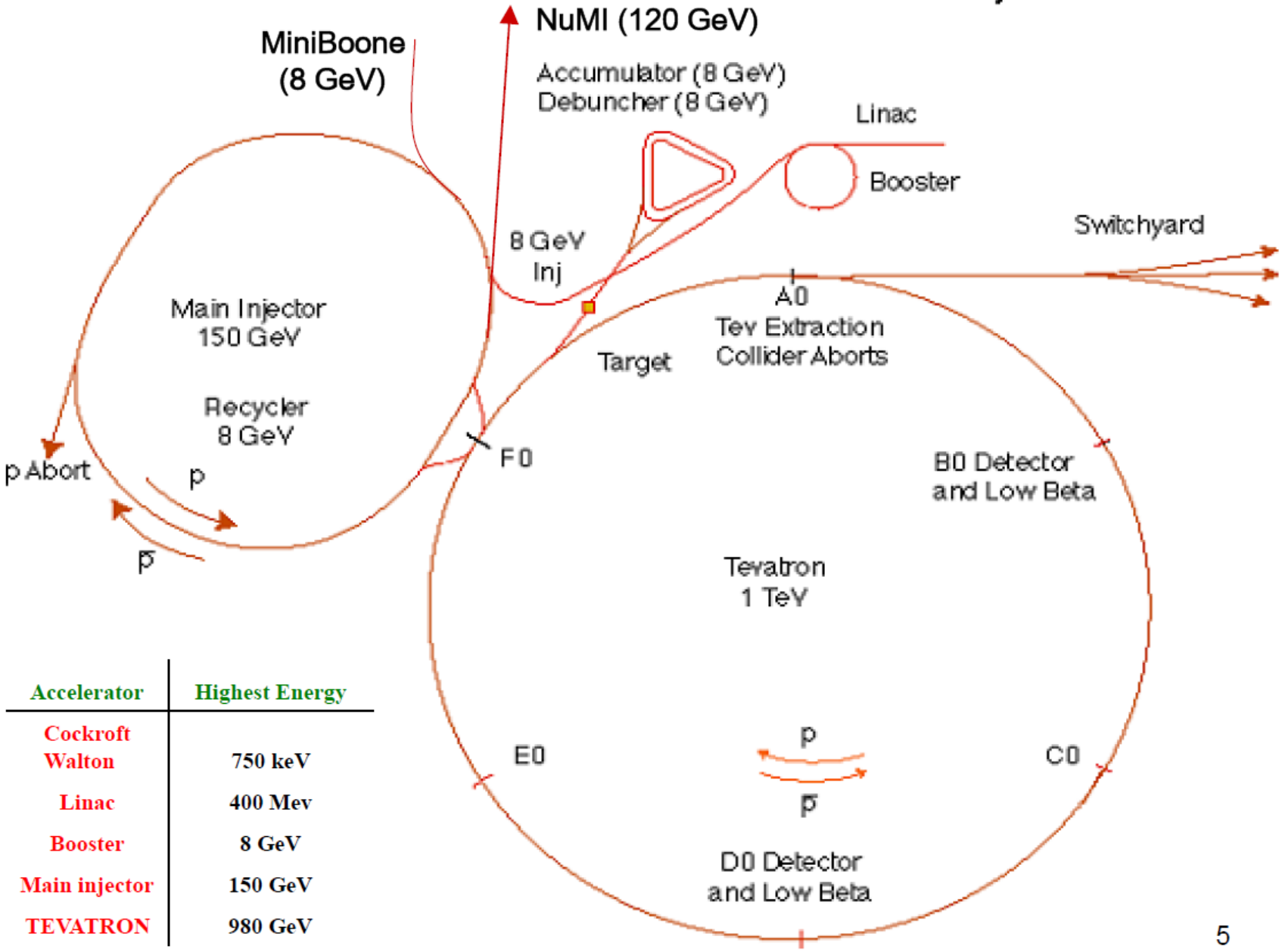


Figure 2.1. Layout of the Mu2e facility (lower right) relative to the accelerator complex that will provide proton beam to the detector. Protons are transported from the Booster through the MI-8 beamline to the Recycler Ring where they will circulate while they are re-bunched by a new 2.5 MHz RF system. The reformatted bunches are kicked into the P1 line and transported to the Debuncher Ring where they are slow extracted to the Mu2e detector through a new external beamline.

FermilabTevatron Accelerator With Main Injector



Accelerator	Highest Energy
Cockroft Walton	750 keV
Linac	400 Mev
Booster	8 GeV
Main injector	150 GeV
TEVATRON	980 GeV

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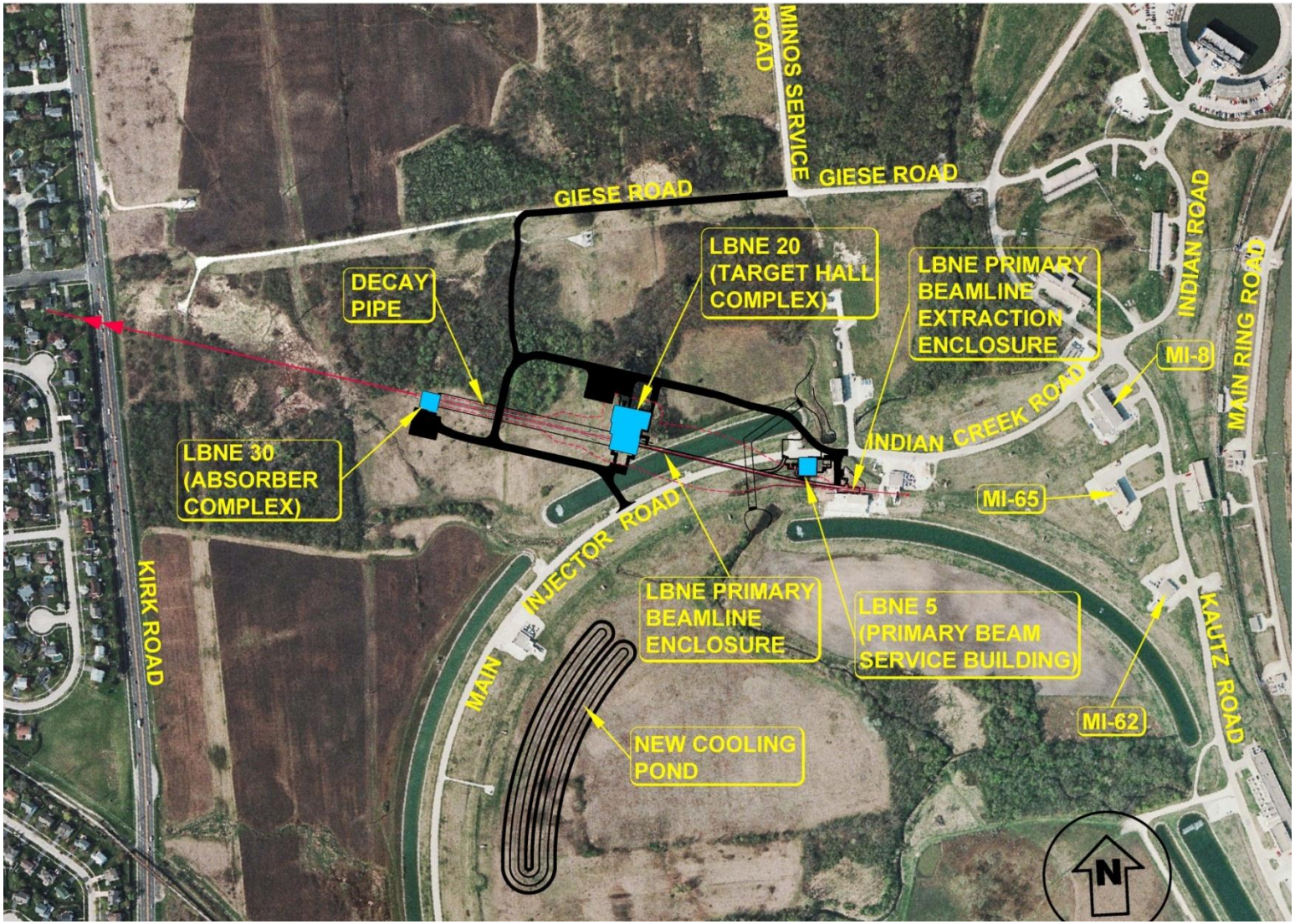
LBNE NS CF Reference Design Scope (T. Lundin)



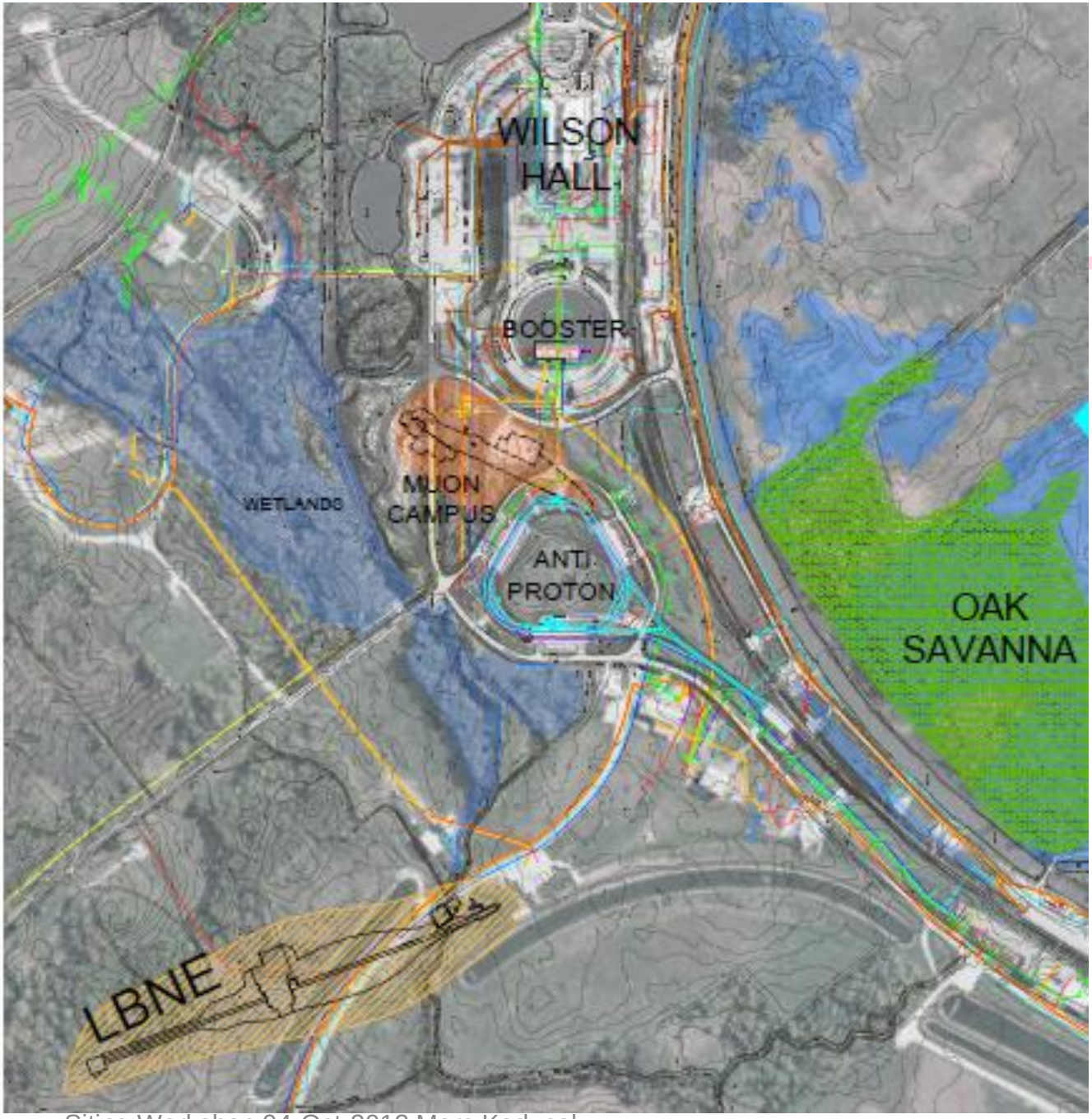
The Muon Campus at Fermilab (C. Polly)

Current plan for Muon Campus is the result of optimizing the program plan to simultaneously meet the requirements of g-2 and Mu2e, while keeping an eye towards future possibilities

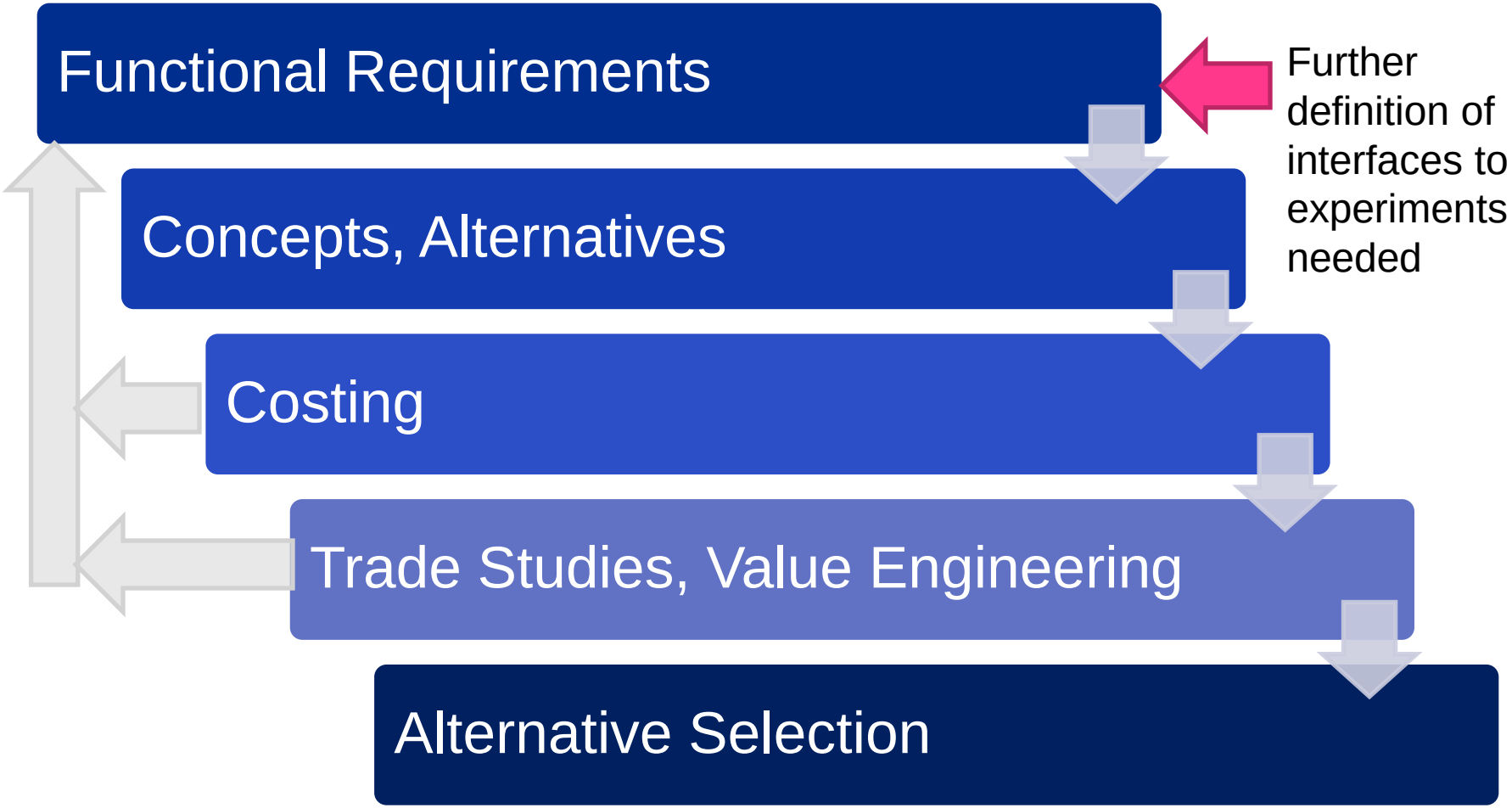
Linac Cryomodule Count

	Section	Freq (MHz)	Energy (MeV)	Qty. Cryomodules Reference Design	Qty. Cryomodules Stage 1	Type	~Length of each CM
CW	HWR (β_G=0.1)	162.5	2.1-10	1	1	HWR, solenoid	5.26 m
CW	SSR1 (β_G=0.22)	325	10-42	2	2	SSR, solenoid	4.76 m
CW	SSR2 (β_G=0.47)	325	42-160	4	4	SSR, solenoid	7.77 m
CW	LB 650 (β_G=0.61)	650	160-460	7	7	5-cell elliptical, doublet	7.1 m
CW	HB 650 (β_G=0.9)	650	460-3000	19	4	5-cell elliptical, doublet	11.21 m
Pulsed	ILC 1.3 (β_G=1.0)	1300	3000-8000	28	-	9-cell elliptical, quad	11.7 m

Project X


WILSON
HALL
BOOSTER
WETLANDS
MUON
CAMPUS
ANTI-
PROTON
OAK
SAVANNA
LBNE

Process (Oversimplified)



1 GeV Linac

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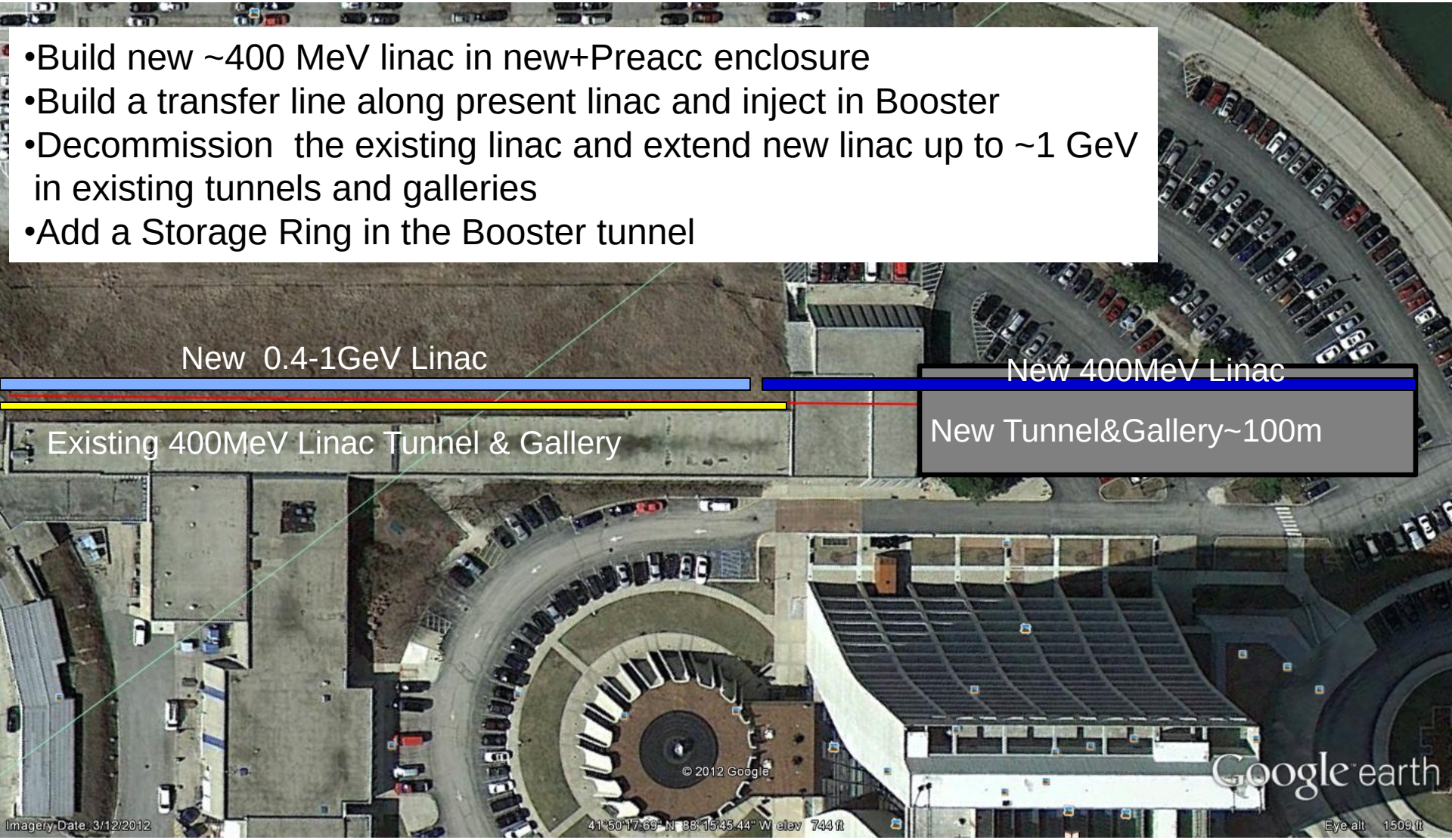

8 GeV Linac, New Siting