



MQXF pre-series and series magnets fabrication plans

Ruben Carcagno
November 19, 2014



LARP



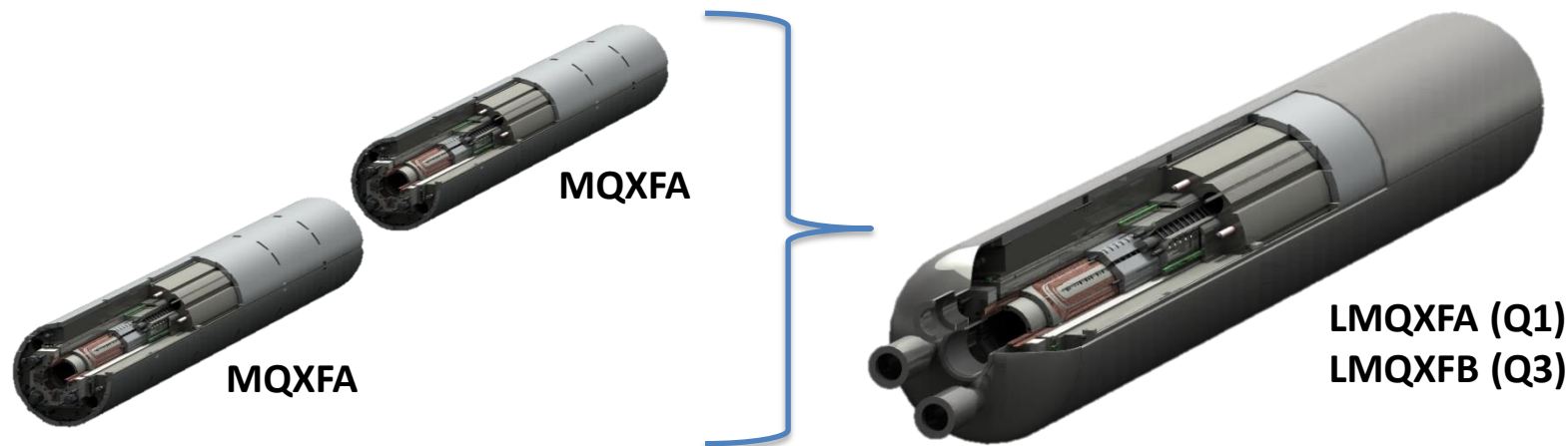
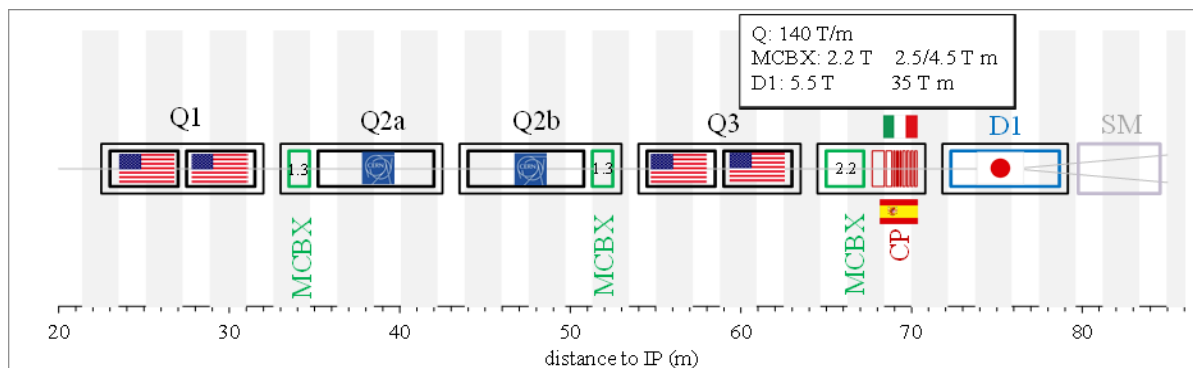
Outline

- US-HiLumi Magnets Preliminary:
 - Scope
 - Top-Level Schedule
 - Fabrication Plan
 - Early US Project Milestones
 - Summary



Preliminary US-HiLumi Magnet Scope

- Five Q1 Cold Masses (LMQXFA) and Five Q3 Cold Masses (LMQXFB)
 - Each cold mass includes two ~ 4.8m Nb3Sn magnets (MQXFA) installed in a SS helium vessel with end domes, ready for insertion into a cryostat by CERN



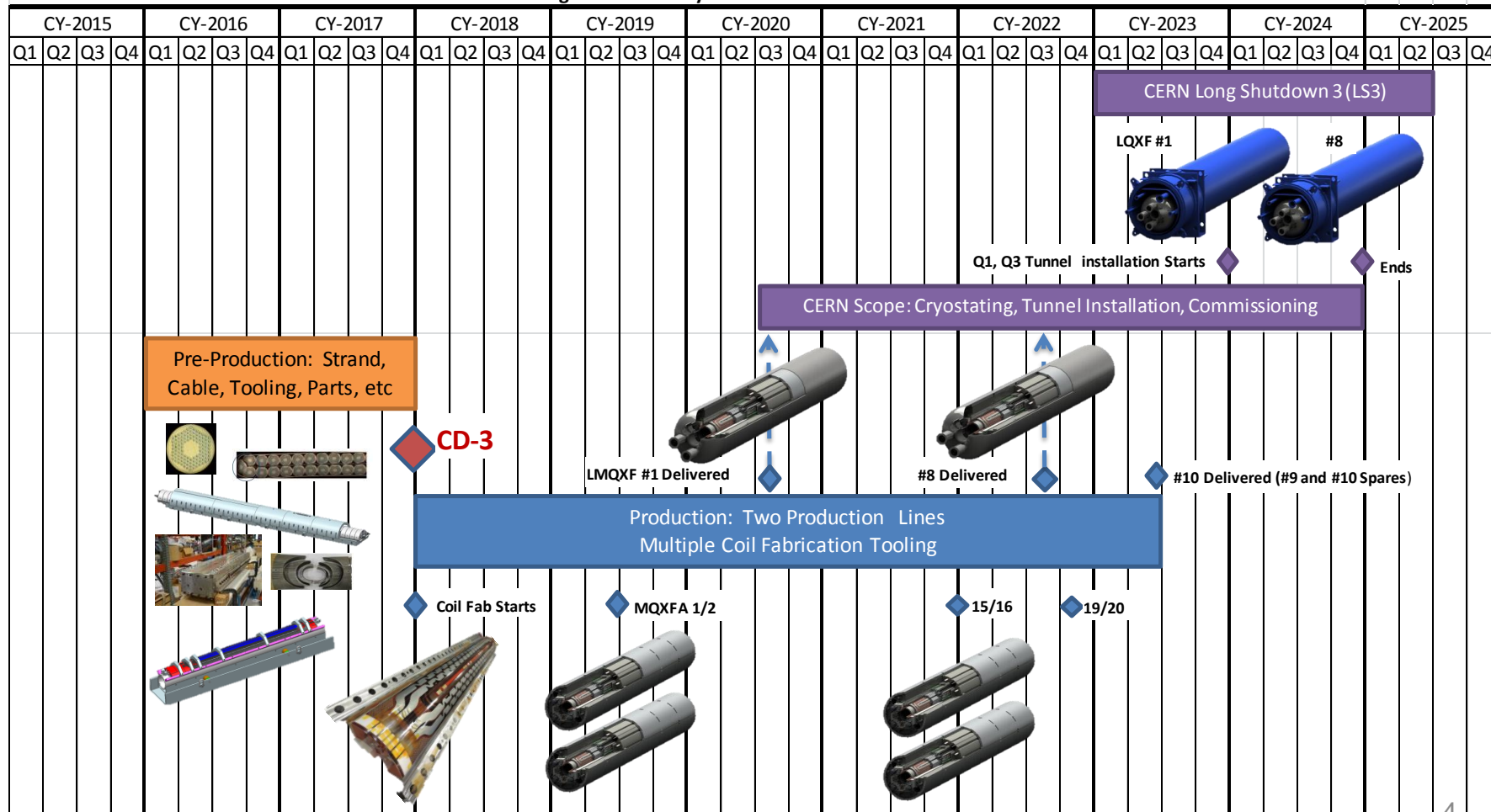


US-HiLumi Magnets Timeline



- Tentative plan:
 - Assumes Q1 and Q3 tunnel installation in CY-2024
 - Provides 3.5 years for CERN Q1 and Q3 scope (cryostating, test, etc)
 - Production Coil winding must start in January 2018 (US Critical Decision 3 DOE approval, CD-3)
 - Two years of preparations needed for strand and series production tooling procurements, start cable fabrication, etc.
 - Production throughput based on June 2013 MQXF fabrication plan

US-HiLumi Magnet Preliminary Timeline - November 2014



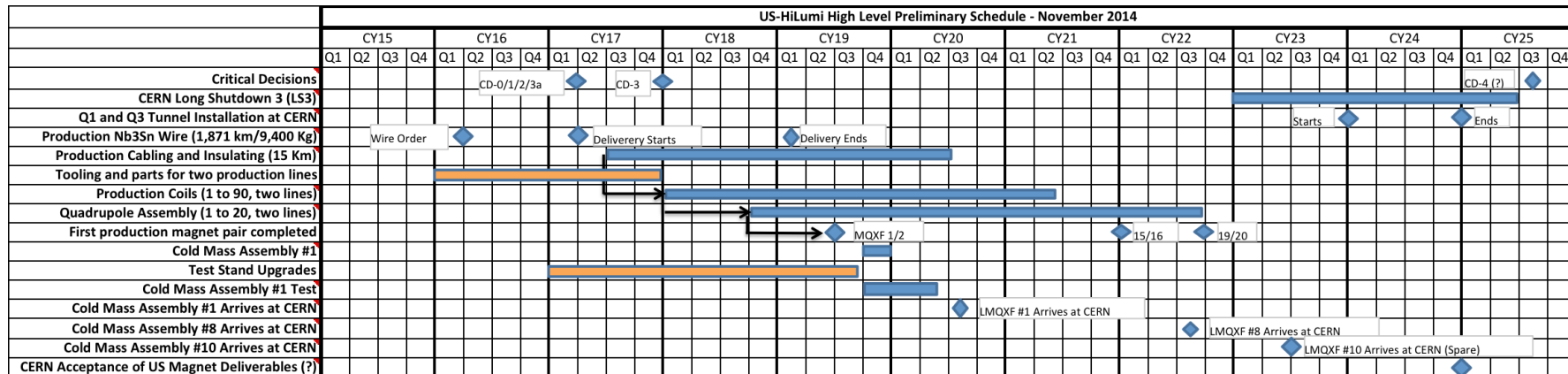


LARP

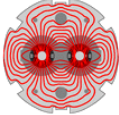
US-HiLumi Preliminary Top Level Schedule



Schedule

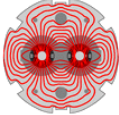


- Assumes Q1 and Q3 tunnel installation in CY2024
- First LMQXFA/B cold mass delivered to CERN summer 2020
- Last LMQXFA/B cold mass for tunnel installation delivered to CERN summer 2022
- Last LMQXFA/B cold mass spare delivered to CERN summer 2023



Preliminary Fabrication Plan

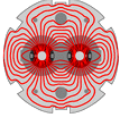
- Plan is based on the production plan presented by M. Anerella during the June 2013 DOE review of LARP plus additional information
- Nb₃Sn
 - First strand delivery one year after placing purchase order. Last delivery 2 years later. A total of 9,400 Kg will be needed for 90 coils
- Cable and Insulation (LBNL)
 - Starts three months after first strand delivery
 - Throughput starts at 2 UL/month, ramping to a peak rate of 3 UL/month
 - A total of 90 ULs are needed for 90 coils
 - Insulation by vendor
 - Total duration ~ 3 years



Preliminary Fabrication Plan (Cont.)

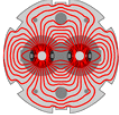
- Coil Fabrication

- Two production lines (FNAL and BNL)
- Peak rate: 1 coil every 15 working days
 - First two coils in each facility assumed to take twice as long
 - First 4 coils: 8 months after coil production starts
- Total duration for 90 coils ~ 3.5 years
- Additional tooling needed at each production line to sustain throughput:
 - One additional winding mandrel assembly
 - Two additional reaction fixtures
 - One additional impregnation fixture



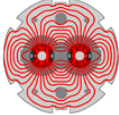
Preliminary Fabrication Plan (Cont.)

- Magnet Assembly (LBNL)
 - Starts ~ 8 months after coil fabrication starts
 - As soon as a set of four coils are delivered
 - Includes Yoke/Shell structure assembly, coil pack insert assembly, and magnet assembly
 - Two production lines. In each line, peak rate:
 - 1 coil pack insert every 60 working days
 - 1 yoke/shell assembly every 75 working days (concurrent)
 - 1 magnet assembly every 34 working days
 - Peak overall rate: 1 magnet every ~ 2.2 months
 - First magnet assumed to take twice as long
 - Total duration for 20 magnets is ~ 4 years



Preliminary Fabrication Plan (Cont.)

- Magnet Test (BNL)
 - Test and train each magnet in BNL vertical test stand prior to cold mass assembly
 - Needed quantity under consideration
 - It takes ~ 38 working days for a production vertical test
- Cold Mass Assembly (FNAL)
 - Connection of two magnets, installation of stainless steel skin and end domes, heat exchanger, bore tube, etc.
 - Peak rate: 1 cold mass every ~2 months
 - First assembly assumed to take 3 months
- Cold Mass Test (FNAL)
 - Insert cold mass in re-usable cryostat and test cold mass in Fermilab's Horizontal test stand
 - Peak rate 1 cold mass test every ~3.5 months
 - First test assumed to take 1.5 times longer, second test 1.25 times longer
 - Assumes no prior magnet training
 - Assumes 30 training quenches per magnet



US-HiLumi Early Milestones

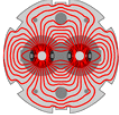
Baseline must be frozen before March 2016

	CY15				CY16				CY17				CY18			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DOE Approvals		◆							◆				◆			
Reviews				◆				◆								
Preparations						◆										
Documentation		◆	◆				◆									

Frozen Baseline:

- Definitive scope
- Detailed resource loaded schedule
- Time-phased budget
- EVMS-ready

- Earned Value Management System (EVMS) monthly reporting is required six months prior to the independent Director’s CD-2 review, which is required before a DOE CD-2 review
- EVMS requires a frozen baseline
 - Changes after baseline freezing require going through a change control and approval process
 - Monthly Cost/Schedule variances must be explained and corrective actions put in place



Summary

- Plan is based on Q1 and Q3 tunnel installation in 2024
- Q1 and Q3 cold masses delivered to CERN starting in summer 2020
 - Last cold mass for tunnel installation delivered summer 2022
 - Last spare delivered summer 2023
- Plan requires start coil production (DOE CD-3 approval) in January 2018
- DOE CD-2 approval needed by ~April 2017
 - EVMS monthly reporting must start by March 2016 to support Director's CD-2 review prior to DOE CD-2 review
- US-HiLumi project baseline must be frozen **before March 2016**
 - Definitive scope, detailed resource-loaded schedule, time-phased budget, EVMS-ready
- This is a **preliminary plan**, more details and analysis needed (e.g., incorporate rework/re-test activities)