US-HL-LHC: Plans for Transition to Project

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Feb 17th, 2014

Summary

- Introduction
- Scope Identification and Definition
- Project Duration & Project Phases
- P5 Process
- June '13 LARP Internal Review
- Funding Needs
- "Projectization" Plans (DOE Order 413.3B)
  - Tailoring to US-HL-LHC
  - Training
  - LLI (Long Lead-time Items)
- Conclusions

Mark's Talk

Ruben's Talk

Idea of this presentation is not to show that *"all t's are crossed and all i's are dotted"* in the plans for transition to Project, but rather to show that we are aware of major areas we need to concentrate on and we are actively working on them !

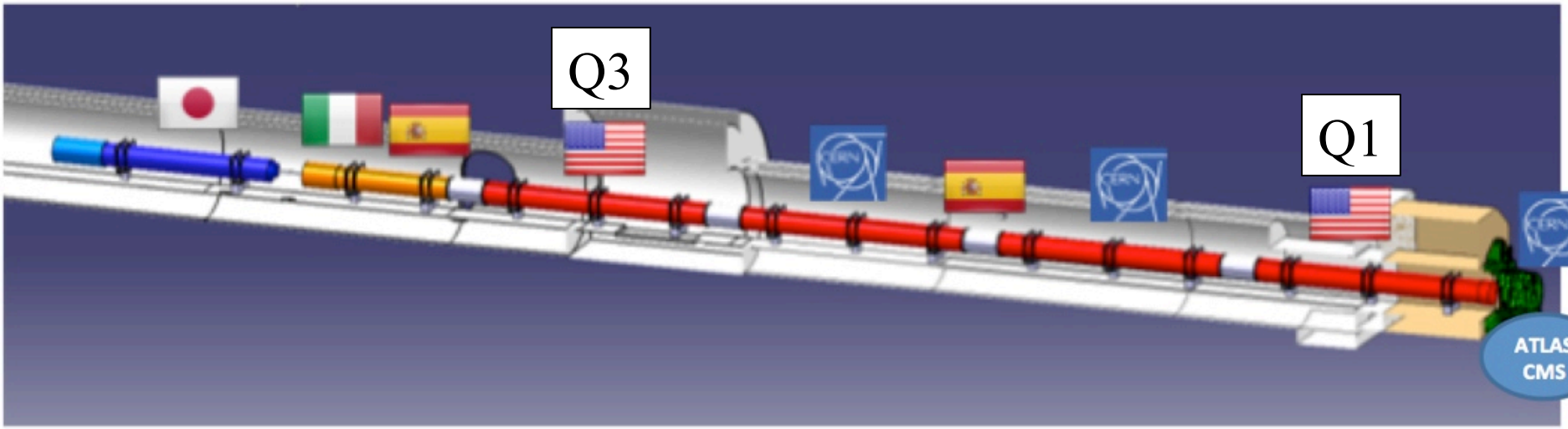
Introduction

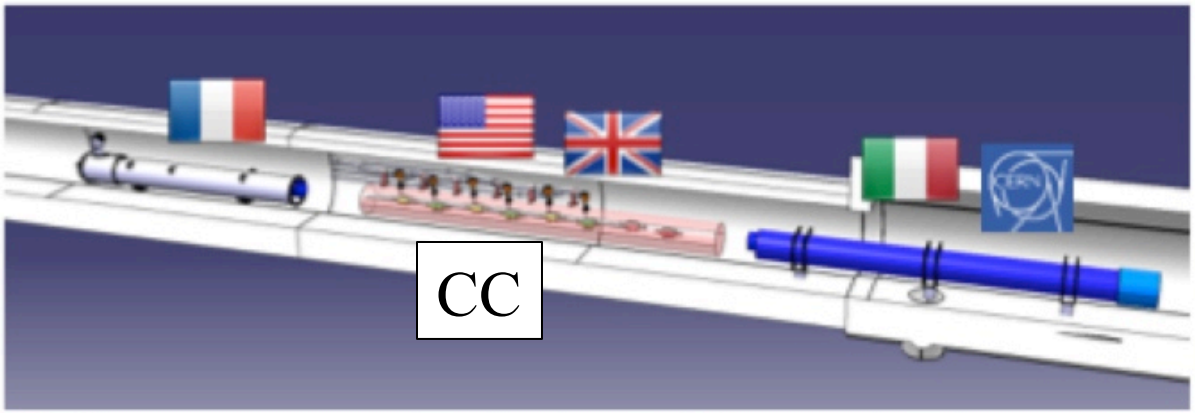
- LARRP to Project Transition
  - LARRP is not misspelled! It's a recognition that the LARP program will be run as a "Risk Reduction" Program in the next ~3.5 years (FY14-FY17)
- CERN Technical Design Report for HL-LHC published by early CY16.
  - Basis for finalization of CERN-US agreement on in-kind contribution.
  - Preliminary agreement (see 1st presentation) foresees deliverables on:
    - IR Quadrupole Focusing Magnets
    - Crab Cavities System
    - Wide Band Feedback System

Introduction (cont.)

- Possible Project Timeline:
  - CD0/CD1/CD2 by mid-FY17
    - CD0 is the time by which TPC is being counted
    - Consolidation proposed in view of continued LARP funding and the schedule needs for HL-LHC
  - CD3 (Construction Start) by early FY18
  - CD4 by end FY23
    - Magnet #18 (for LHC installation) would be delivered to CERN by mid-'22, 3y in advance of LS3 end
  - Need for Raw Material procurement funds (mostly Nb_3Sn SC strand and Magnet Fabrication tooling) in FY16 and FY17
    - Total contract value for Nb_3Sn: ~15 M$
    - Possible paths:
      - Procurement through a Lab "Special Process Spare" account with HL-LHC Project purchasing out of "Spare" when MIE-OPC funds are available.

In-kind contribution and Collaboration for HW design and prototypes





CC : R&D, Design and in-kind **USA**

CC : R&D and Design **UK**

Q1-Q3 : R&D, Design, Prototypes and in-kind **USA**

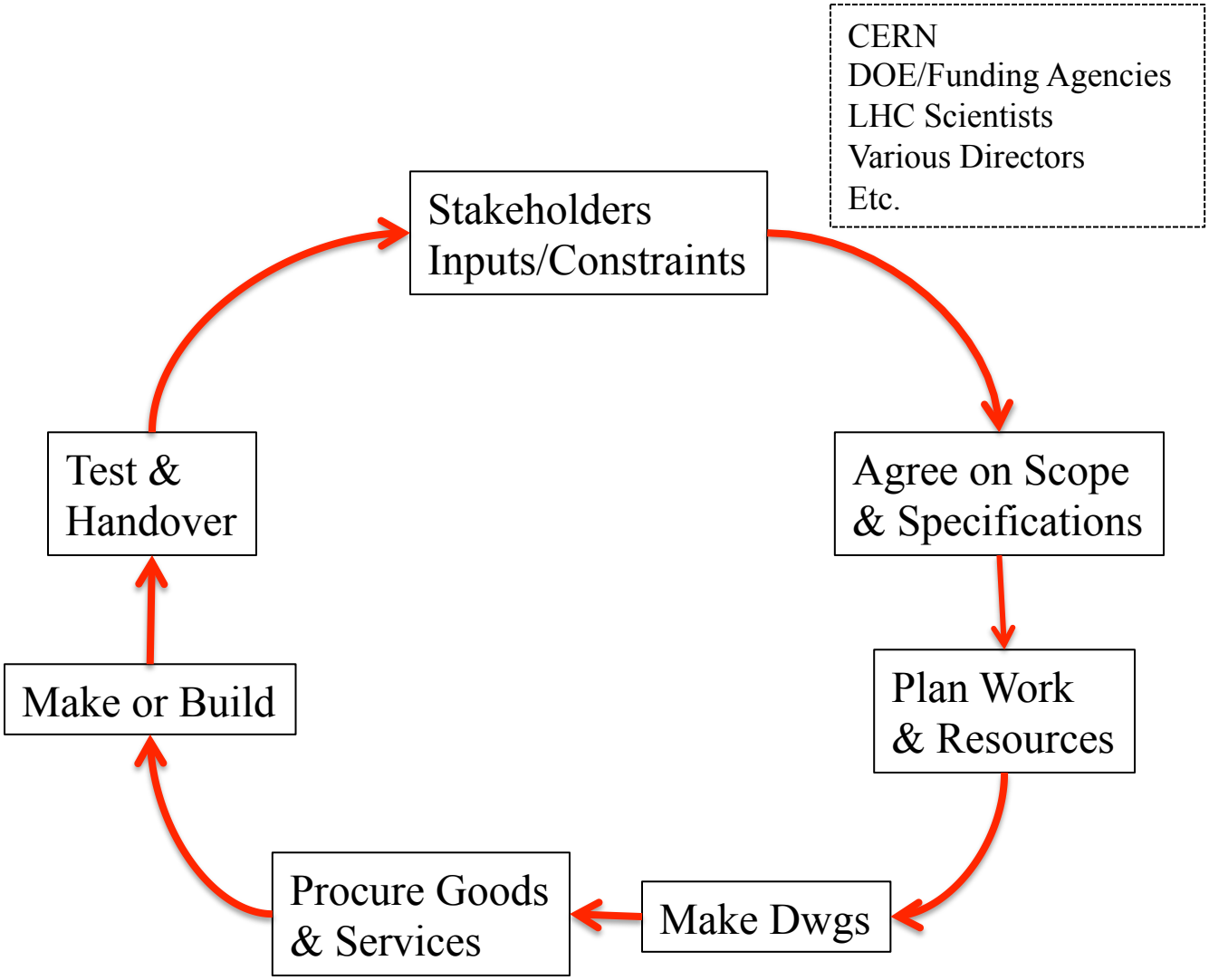
D1 : R&D, Design, Prototypes and in-kind **JP**

MCBX : Design and Prototype **ES**

HO Correctors: Design and Prototypes **IT**

Q4 : Design and Prototype **FR**

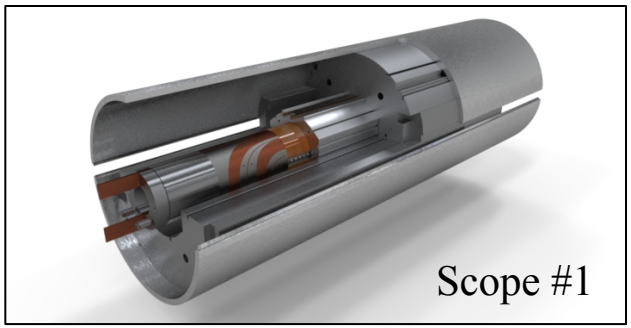
"Phases" of (any) Project

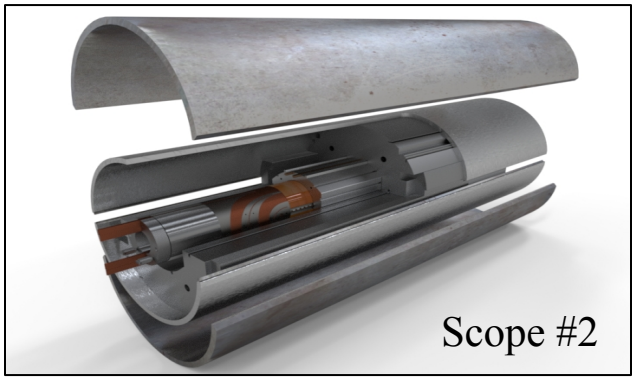


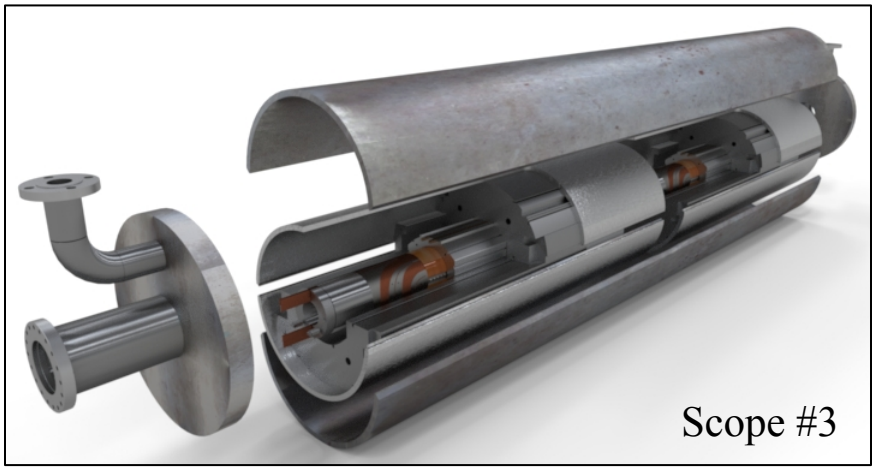
SCOPE/TIME/COST Triangle

- A successful project must satisfy three basic objectives:
  - Cost: all the work must be finished within budget
    - Initial discussion placing US HL-LHC contribution in the ~200 M$ range in then-year $.
  - Schedule: the project must finish on time
    - End of LS3 must see elements integrated and performing in the LHC tunnel
  - Scope: amounts of performing deliverables
    - Product must be fit for intended purpose (also "quality")
- It is probably not incorrect to state that "cost" and "schedule" appear to be less flexible – at this time – than "scope"
- Once "Cost" is defined by appropriate negotiation among Project stakeholders, "scope" for US in-kind deliverables needs to be handled between US-Project Office and CERN.
- Ex: QXF deliverable/CC Deliverables

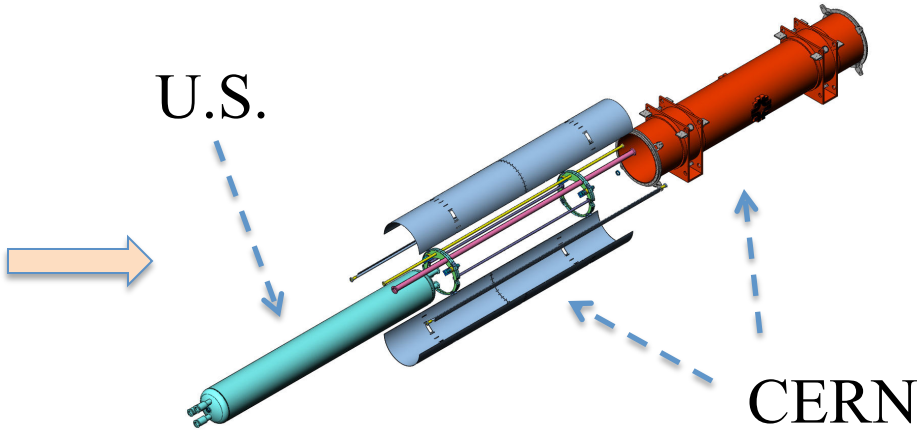
Example: QXF Deliverable



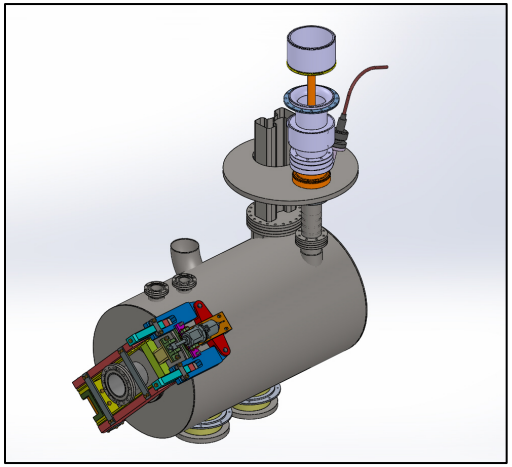


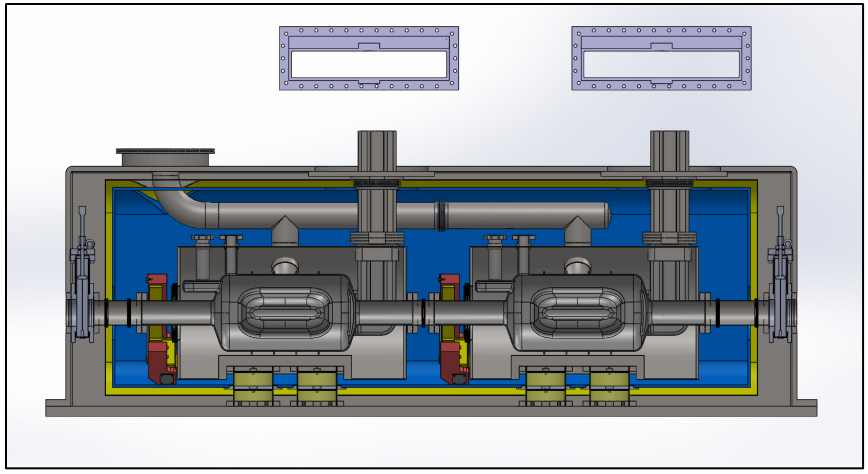


- Options
  1. Cold Mass (coils and Al. Shell), ~4.8 m long, no test
  2. He SSL vessel 4.8 m long single coil magnet to be aligned and welded at CERN, tested in some way or form.
  3. Fully finished SS He Vessel double magnet, ~10 m long, with inter-magnet connection(s)



Example: CC Deliverable





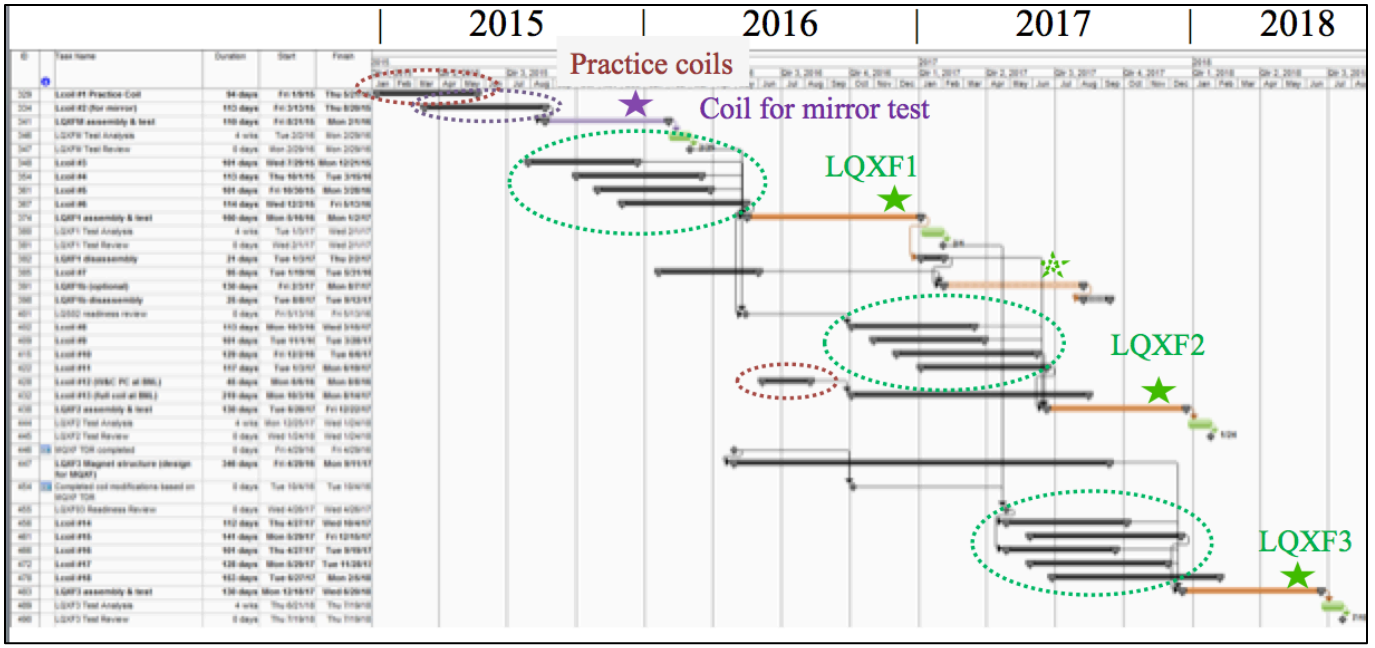
- Original (CY2012) Idea
  - Delivery of cryostat and 3 cavities/beam for each beam and each HL Interaction Region (total of 24 cavities and 8 CMs).
- Further Developments
  - Safety margin needs on field for CC kick pushed CERN to increase the number of CC from 3 to 4 per beam.
  - LCLS-II (a major DOE priority) is drawing heavily on cryogenic expertise in US National Labs.
  - Strong Cryomodule design effort developed in UK-CERN Collaboration

Scope Negotiation

- Converging with CERN on possibility of delivering "dressed-cavities" (i.e. cavities in He-Vessel with all functional ancillary equipment such as HOM couplers, fast and slow tuning mechanisms, etc.) for installation in CM at CERN

Planning of Work

(plan the work – get "go ahead" – work the plan)

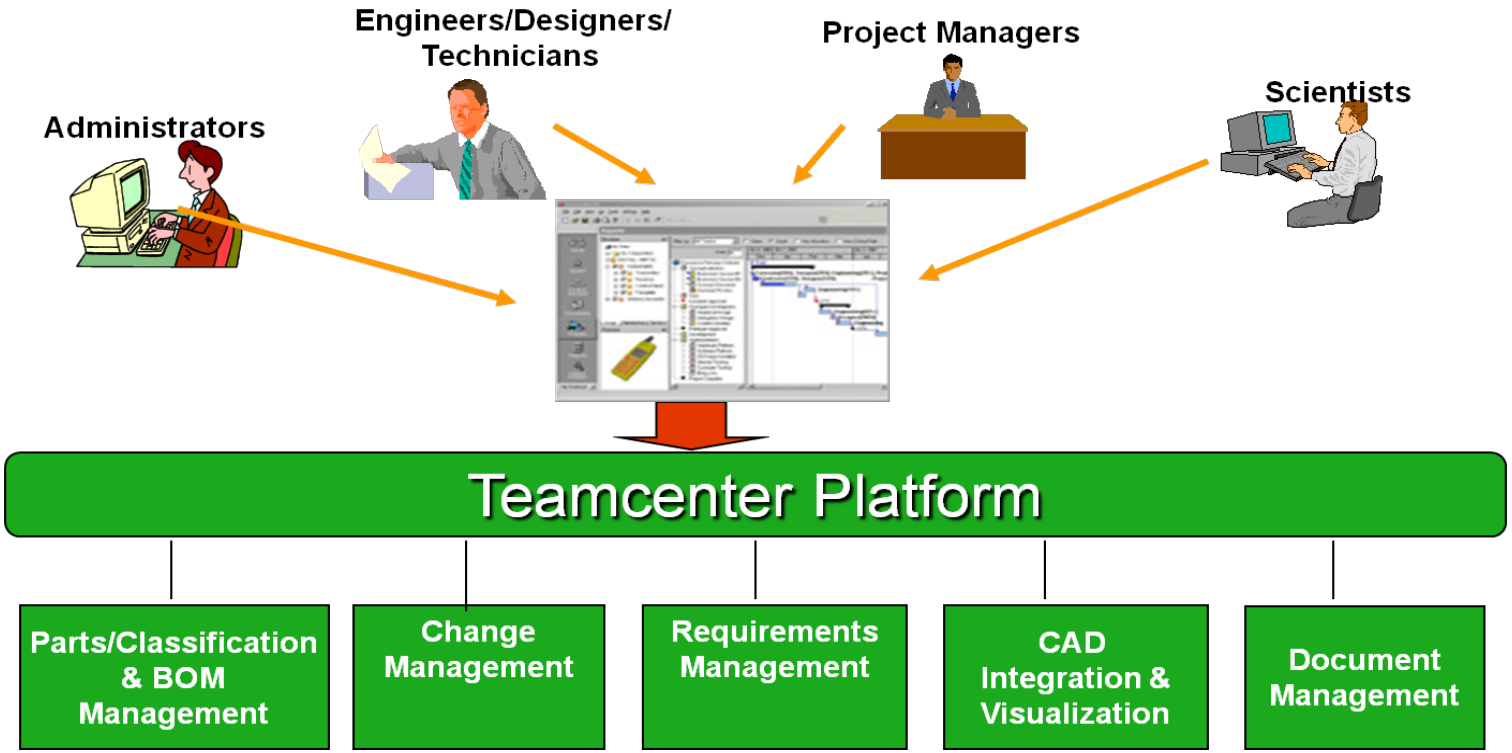


- What needs to be achieved in plans where:
  - Tasks shown in logical sequence
  - Tasks dependencies are shown
  - Plan is visually effective
  - Detail is adequate to monitor progress
  - Plan is flexible, can be changed and highlights priorities
- Strategy
  - Enforce Plans and Product Oriented WBS structure usage within LARP during the next ~3.5 year

TeamCenter

Engineering Database Management System

- Key Capabilities
  - CAD integrations, Main storage for engineering documents, Workflow processes, Bill of material management, Requirements and specifications, Change management, Electronic signoff
- Interfaces with various CAD packages and with CERN EDMS to be addressed



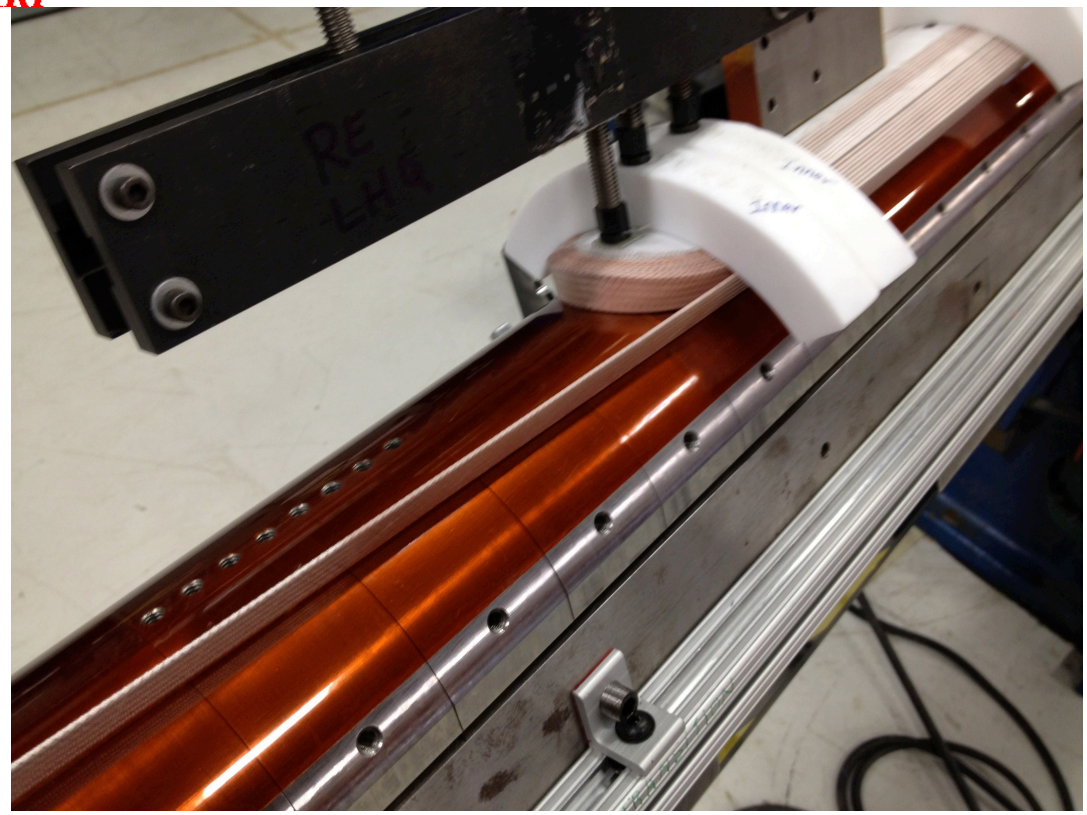
Strategy for Work Plan

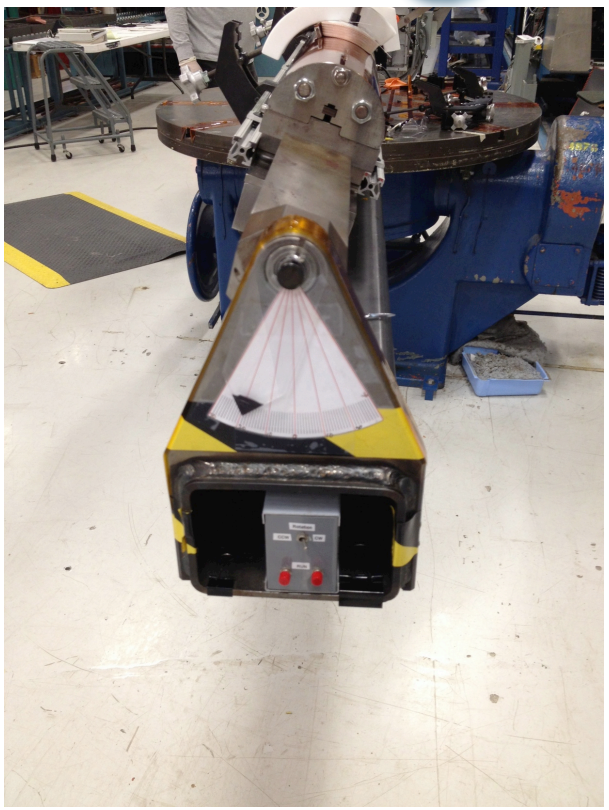
- Slowly transition from "Virtual Lab" model to "Competencies-based Lab" model
  - Core competencies relied upon to permit cost savings for the project execution phase
  - "Virtual Lab" legacy is the realization that there is hardly a "Sole Source" when it comes to HL-LHC deliverables for QXF
- Core competencies comes with real R2A2 (role, responsibility, authority, accountability)
  - My own personal working model (to be discussed and negotiated in the near future in preparation for the "projectized phase"):
    - QXF Magnets
      - FNAL: Coils & Testing
      - BNL: Coils & Conductor&Testing
      - LBL: Mechanical Structure, Cabling and Conductor
    - CC
      - LBL/ODU/BNL/FNAL: Cavities
    - WBFS
      - SLAC

Procurement Plans

- Make full use of Organizational Assets (i.e. Procurement Departments in various Labs)
  - Specs
  - Make-or-buy
  - Vendor Conferences
  - Bids Evaluation (not only $)
  - Vendor Oversights, Inspection and Audits
  - QC
- Big Gorilla in the room: some form of Nb_3Sn strand procurement order (~several M$) to be placed in FY15 (or FY16 at the absolute latest) to insure arrival of ready-to-wind-cables by FY17/FY18
  - Internal Strand/Cable HiLumi/LARP Review in Oct '13
  - External Review and final endorsement by Summer/Fall '14

Assembly Procedures/Travelers





- Vital to capture in written form all "know-how" matured in LARP in the last 10 years
  - Coil Making
  - Reaction Process
  - Structure Assembly
  - Etc.

Test & Hand-over

LARP

LARP QXF QUADRUPOLES

FUNCTIONAL TEST REQUIREMENTS

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A thermal cycle will be included to verify that the cold mass retains its training.

Detailed specifications about these measurements will be provided in the Technical Requirements Specification (TRS) [3] and corresponding test plans. Major parameters required for these measurements will be specified in this document. Presently, the following numbers of quenches (based on HQ and LQ tests) are suggested for planning purpose: 50 quenches at 1.9K, 10 quenches at 4.5K, and 3 quenches at 1.9K after the thermal cycle.

Production Testing (MQXF)

The primary objective of the production testing phase is quench training and quality assurance. Each cold mass will be tested and trained prior to delivery to CERN to verify that the cold mass satisfies specifications such as operating current margin and magnetic field quality. The test cycle of production magnets is expected to be shorter: production magnets will not have R&D instrumentation, and a thermal cycle may not be part of the test plan if the R&D testing demonstrates sufficient training memory. Presently, the following numbers of quenches are suggested for planning purpose: 30 quenches at 1.9K, 3 quenches at 4.5K, and 3 quenches at 1.9K after the thermal cycle.

The exact configuration for MQXF cold mass testing has not been decided yet, and it depends on the final agreement between the US and CERN for the MQXF deliverable. The following options are possible examples:

(1) Testing a single MQXF cold mass with or without the stainless steel shell on a vertical test stand

(2) Testing a single MQXF cold mass with a stainless steel shell on a horizontal test stand

(3) Testing a double MQXF cold mass with a Stainless Steel shell on a horizontal test stand. In this case, the test stand should be capable of powering each cold mass independently and together.

For options (2) and (3), a reusable cryostat where the cold mass is inserted and then removed would be needed for testing.

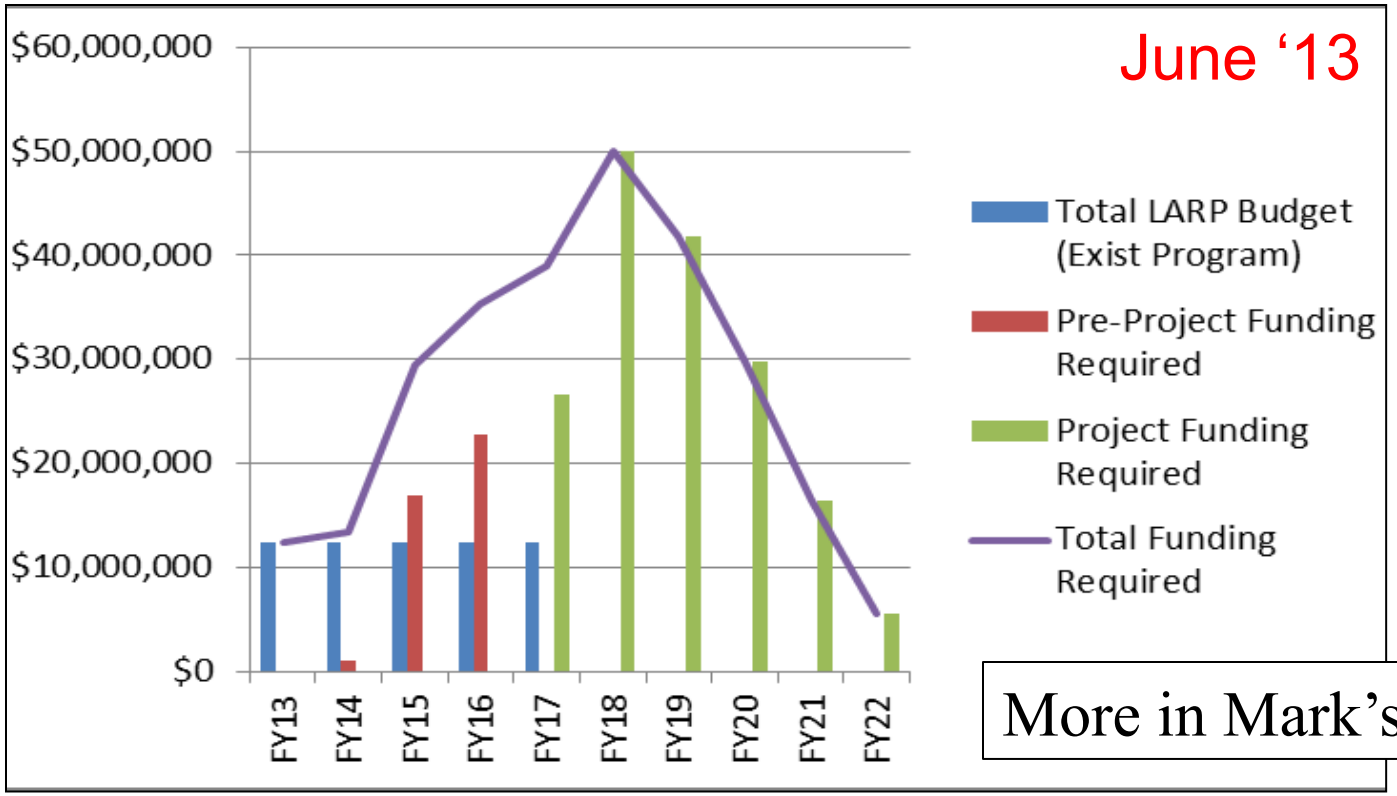
4. Cooldown Requirements

During cooldown and warmup, the maximum temperature gradient between magnet ends shall be kept below **100K** to avoid excessive thermal stresses. This requirement may be relaxed during production tests, nonetheless the test facility should have this capability.

5. Temperature Accuracy and Control Requirements

June '13 Internal Review

- In June '2013 LARP organized an Internal Review on Schedule and Cost of US-HL-LHC in-kind contribution:
  - LARP continues until FY17 (included)
  - Pre-project Funding: ~ 40 M$ in FY15-FY16
  - Project Funding: ~170 M$ in FY17-FY22
- New CERN schedule and earlier considerations on US-LH-LHC Timing allowed an alternative schedule with a smoother funding profile to be prepared



More in Mark's Talk

Jun '13 LARP "Project" Review Main Feedbacks

- Magnets
  - The technical feasibility of the quad program seems reasonable.
  - The cost have a decent basis in the LARP R&D program
  - The scope is reasonable for a $200M US contribution.
  - The major uncertainties and risk appear to be programmatic in nature.
- CC
  - The down selection on the cavity choice drives the schedule and should be made as soon as possible.
  - Closely monitor integration of LARP funding, CERN schedule, GARD funding & priorities, and SBIR performance since they are all external risk elements…
  - …..
- Feedback System
  - Presented schedule estimates are optimistic and have minimal headroom to react to additional budget pressures.
  - To meet LS2 schedule for installation into the SPS, the engineering effort must clearly pivot from development mode to production mode by 2017.
  - We feel that proposed manpower allocations may be underestimated. To appropriately amortize the engineering work done in the research phase of the project (through 2016), there has to be continuity in engineering manpower.
  - …..

P5 Process

- P5 (Particle Physics Project Prioritization Panel) is charged with developing a strategic plan for the US over a ten-year time scale with a twenty year global vision for the field under various budget scenarios.
- LARP/US-HL-LHC input provided at P5 Workshop in Brookhaven National Lab (Dec 15th-18th, 2013)
  - Well received (from individual interactions with Panel members)
- (Main) Question from panel:

> 1) What is the absolute must-do core set of upgrades? What are the collaboration's (US and worldwide) highest priorities and why? What would happen if the US resources available for the upgrades were reduced by 25%? or 50%? What flexibility is there in the timing and phasing of the upgrade funding?

P5 Process (cont)

- Answer:
  - First 25% reduction already achieved by excluding from initial deliverable discussion 11T dipoles and e-hollow electron beam.
  - Additional 25% reduction would obviously leave very little room for anything beside Nb_3Sn IR quadrupoles contribution.

- Need for new US-HL-LHC cost estimate based on new schedule and new set of scope deliverables probably later in this year (or early next year) after P5 report and PDR to establish TPC.

Where do we go from here

- CD0/1/2 in FY17 with MIE funds coming in the same year implies:
  - DOE to consider US-LHC funds inFY17 within the FY15 budget preparation process (deadline for start in June 2014)
  - Exhibit 300 Capital Asset Plan and Business Case form
    - Need to be filled and submitted for budget request.
    - Planning for 22.7 M$ in FY17 (see Mark's presentation)
      - Risk if Continuing Resolution/Government Shutdown
- LLI procurement in FY16 of SC strand (see Ruben's and Mark's presentations)
  - One possible solution:
    - 10 M$ in FY16 to FNAL for "Special Process Spare"
    - Conductor to be purchased out of "Special Process Spare" when MIE funds are available
- Federal Project Director assignment appears to be of the outmost importance to start navigating properly the "Projectization" waters.

Conclusions

- General understanding on need to transition to "projectized approach" being implemented in LARP
- Need convergence on Scope & Deliverables after P5 Report
- Need new Cost/Schedule estimate after P5 Report and DOE Profile Guidance
- Project "prototyping needs" will be absolutely dependent on appropriate LARP funding
- Training/Development of US-HL-LHC L2 Managers will be an essential part of preparation for Project
- "LLI" funds proposed solution in FY16, MIE in FY17 & Federal Project Director assignment are of the outmost importance

Support Slides

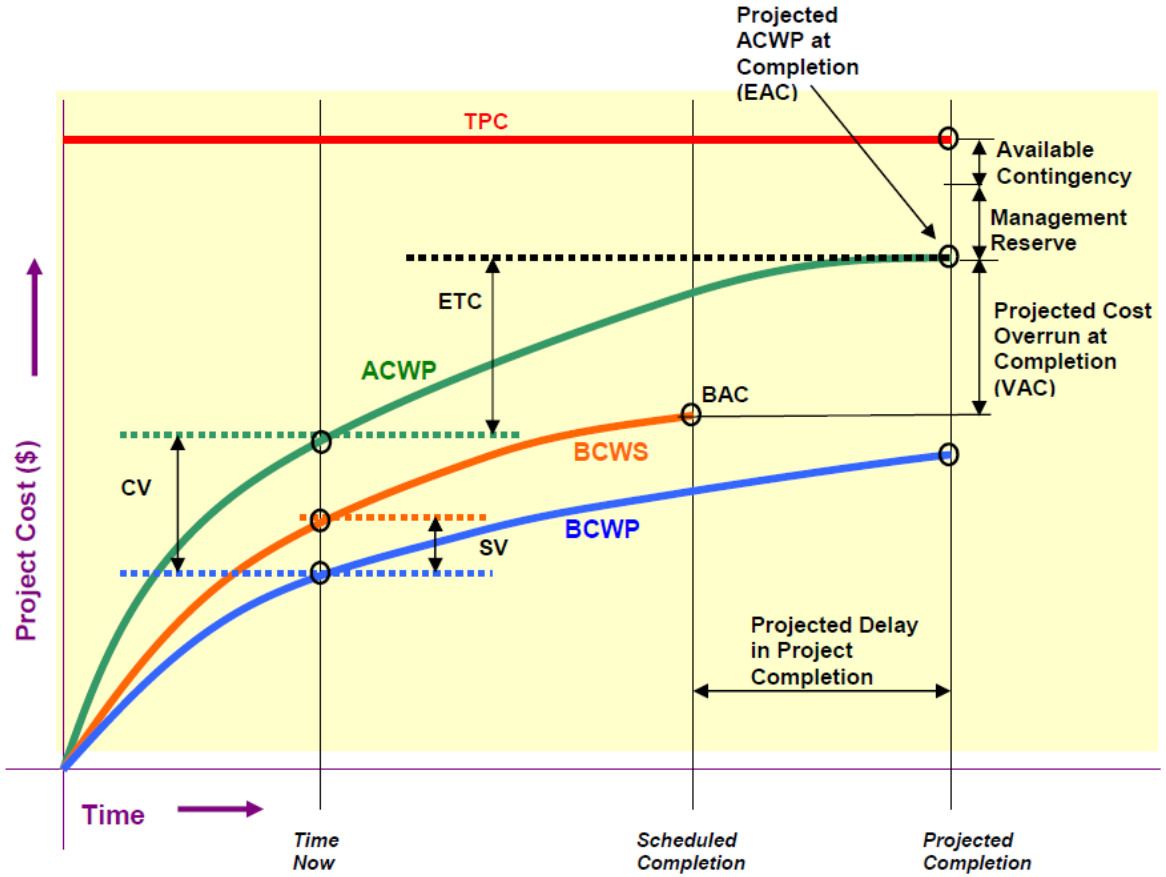
EVMS Data Elements

Performance Formulas

CV = BCWP – ACWP
SV = BCWP – BCWS

CPI = BCWP / ACWP
SPI = BCWP / BCWS

VAC = BAC – EAC



Overall Status

Percent Complete = BCWP $_{CUM}$ / BAC

Percent Spent = ACWP $_{CUM}$ / BAC (OR EAC)

Variance Analysis
Control Account Reporting Thresholds

Variance Analysis Thresholds for Control Accounts		
Green Thresholds – Cost and Schedule Performance falling outside of yellow or red thresholds		
Yellow Thresholds		
Cost Variance Schedule Variance	**Type**	**Threshold limit**
Dollars	Current Period	≥ ± 5% to < ± 10% and ≥ $50K
	Cumulative	≥ ± 5% to < ± 10% and ≥ $100K
Hours	Current Period	≥ ± 5% to < ± 10% and ≥ 350 hrs
	Cumulative	≥ ± 5% to < ± 10% and ≥ 700 hrs
Red Thresholds		
Cost Variance Schedule Variance	**Type**	**Threshold limit**
Dollars	Current Period	≥ ± 10% and ≥ $100K
	Cumulative	≥ ± 10% and ≥ $200K
Hours	Current Period	≥ ± 10% and ≥ 700 hrs
	Cumulative	≥ ± 10% and ≥ 1400 hrs

Note: This applies to SV% (Schedule Variance in %) or CV% (Cost Variance in %) and the SV or CV in $ or hours.

- Apply at Control Account level
- Red trigger requires variance analysis report to be written
- Default thresholds – more restrictive thresholds can be used with customer and senior management approval
- L2 US-HL-LHC Project Managers training will be essential !