



LARP as Risk Reduction for the HL-LHC Project: LARRP

~~LARP: Making the "R" Silent~~

Organization, Budget, Integration of GARD and
Integration LARP/HL-LHC

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FSU LTSW3rd Joint HiLumi LHC-LARP Meeting, Nov 11-15, 2013



Plan



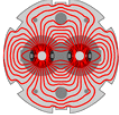
- Intro
 - Risk Reduction Tools
 - 10-y of LARP know-how and next QXF Prototypes
 - US-SRF Infrastructure and know-how and CC Prototypes
 - SLAC know-how, LARP LLRF experience and HBFS Prototype
 - Engineering Practices
 - Process Documentation
 - Schedule Integration
 - Path to “Projectization”
- Funding



LARP History and Transformation



- The US LHC Accelerator Research Program (LARP) was formed in 2003 to coordinate US R&D related to the LHC accelerator and injector chain at Fermilab, Brookhaven, and Berkeley
 - SLAC joined shortly thereafter
 - Has also had some involvement with Jefferson Lab, Old Dominion University and UT Austin
- LARP has contributed to the initial operation of the LHC, but much of the program is focused on future upgrades
 - Increase Luminosity
 - Handle Beam properly (decrease PU linear density)
 - “Interaction less” beam pipe
- The program is currently funded at a level of about \$12-13M/year, divided among.
 - Magnet research (~half of program)
 - Accelerator research (Crab cavities, WBFS, Collimators, e-hollow lens,..)
 - Programmatic activities, including support for personnel at CERN
- **FY13-FY14 Evolution**
 - Initial convergences on deliverables for HL-LHC
 - Program to be handled like a “project”



US in-kind Contribution to HL-LHC: a preliminary look

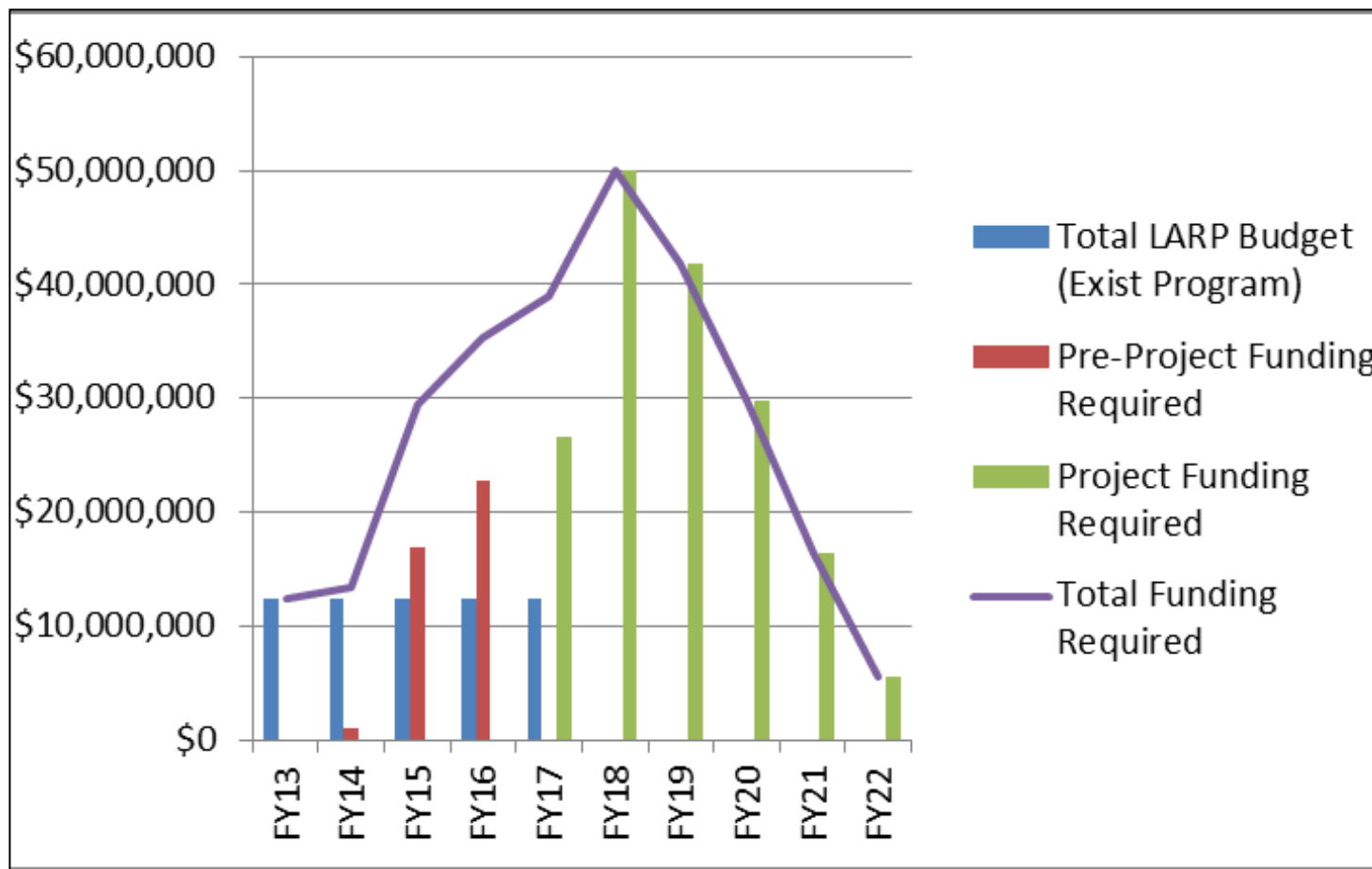


- Various Candidates:
 - 150 mm aperture Nb₃Sn quadrupoles
 - Crab Cavities
 - High Bandwidth Feedback System
 - Collimation and hollow e-beams
 - 11 T Nb₃Sn dipoles
 - Large Aperture NbTi D2 separator magnets
- Process of convergence among CERN-DOE-U.S. Labs-LARP initiated in Dec '2012
- Initial consensus on core Priorities:
 - Committed to a major stake in Nb₃Sn quads
 - Crab cavities up to the SPS test and possibly beyond to production
 - High bandwidth feedback was seen as a high impact contribution for modest resources.
- Back up options.
 - 11 T dipoles
 - Proper “hand-off” if not continued in US
 - Hollow electron beams for halo removal
 - Support R&D into this effort in the event it's chosen as a primary technology and circumstances allow its funding.
- Low priority
 - There was not much interest in pursuing the D2 separators.

Possibly 75% of US
Contribution to HL-LHC



Internal LARP “Project” Review Funding Needs



- LARP continues: ~12.5/y M\$ until FY17
- Pre-Project Funding: ~40 M\$ in FY15-FY16
- Project Funding: ~170 M\$ in FY17-FY22



Internal 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.
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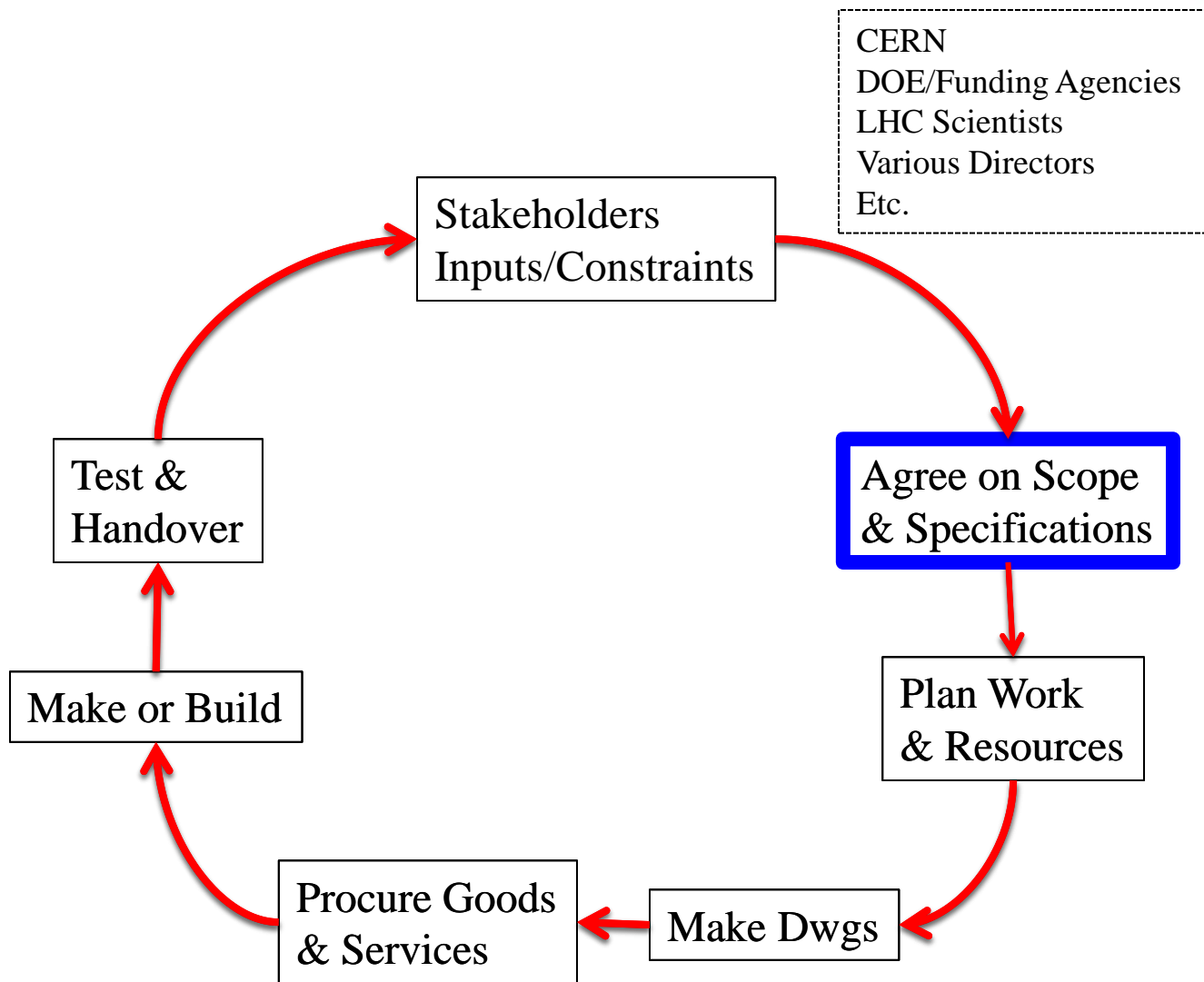
LARP - How to loose “R”:



- **What is a Project:**
 - A temporary endeavor undertaken to create a unique product, service or result.
 - Novelty & Risk
 - LARP experience provides a huge know-how pool and a strong basis on how to build MQXF magnets. However, it is a correct statement to say that at this time we don't know how the 150 mm QXF prototypes will perform.
 - LARP funding in the 2014-2017 timescale need to be used to reduce risk to a minimum:
 - No “prototyping” during 2018-2021 construction phase. No PED funding as well.
- Final design and reproducibility issues addressed during LARP phase
 - Challenge: Magnets effort invested ~65M\$ in '03-'13. At present funding levels, ~25M\$ should bring us from where we are today on QXFs to a “ready to construct” product.
 - In the following will discuss some basic Project “Motherhood and Apple Pie” concepts applied to the Magnet QXF effort.



Phases of (any) Project

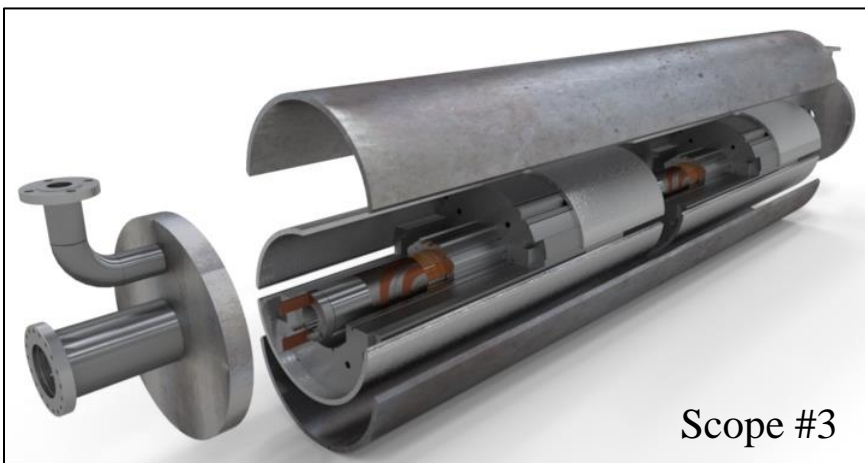
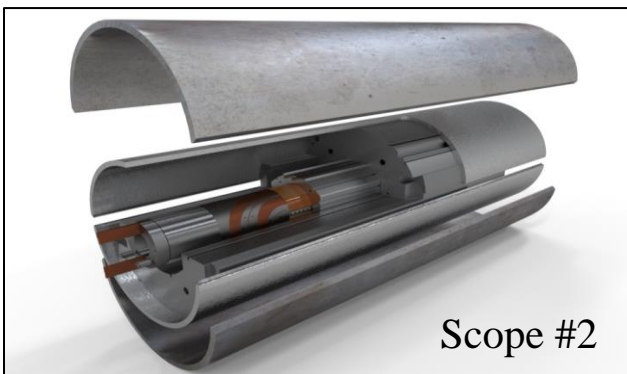
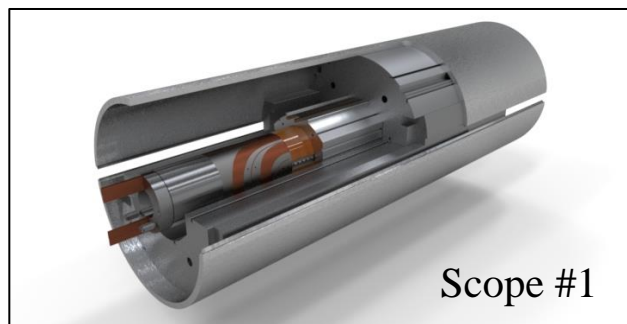




SCOPE/TIME/COST Triangle

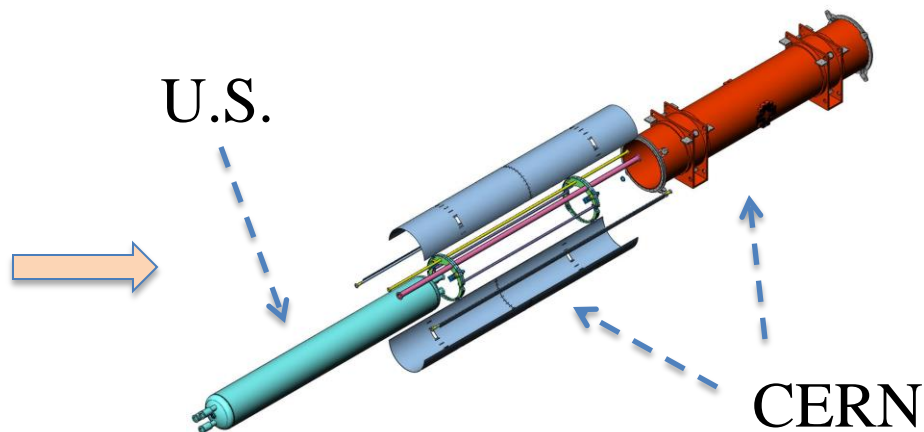


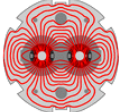
- A successful project must satisfy three basic objectives:
 - Cost: all the work must be finished within budget
 - Initial discussion placing US HL-LHC contribution in the ~200 M\$ range in FY13 \$
 - Schedule: the project must finish on time
 - End of LS3 must see elements integrated and performing in the LHC tunnel
 - Scope: amounts of performing deliverables
 - Product must be fit for intended purpose (also “quality”)
- It is probably not 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



Options

1. Cold Mass (coils and Al. Shell), ~4.3 m long, no test
2. He SSL vessel 4.3 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, ~9 m long, with inter-magnet connection(s)



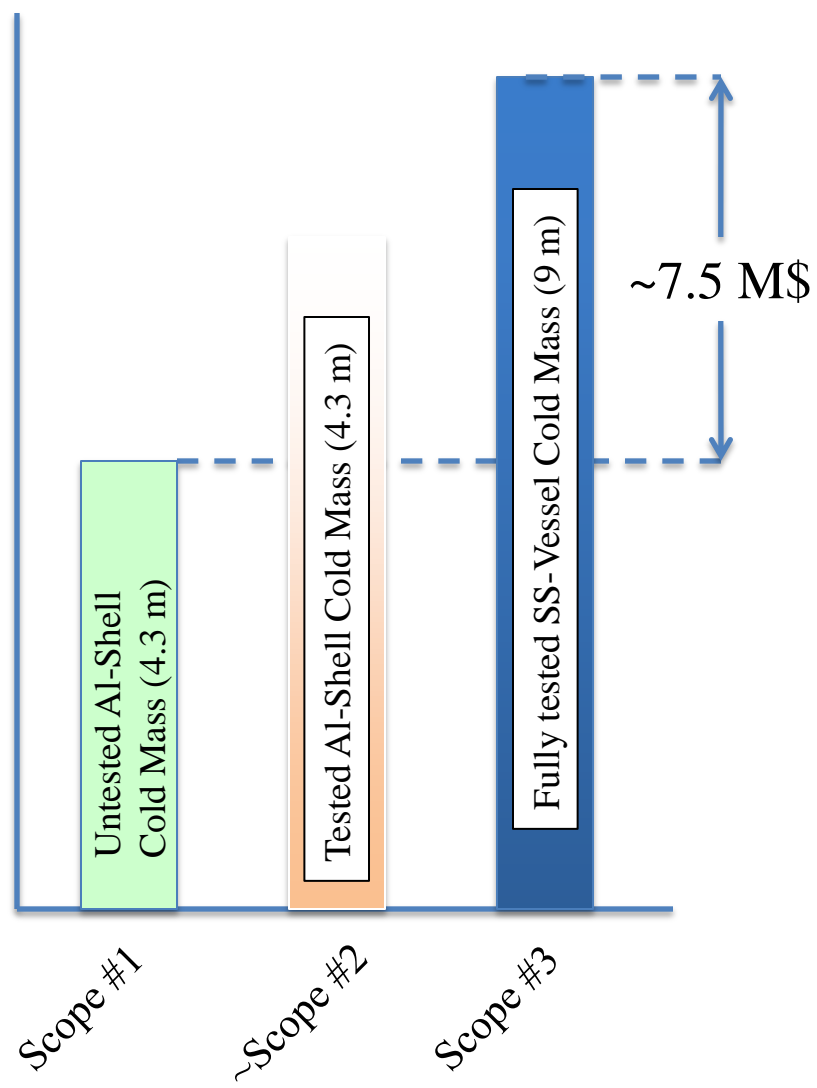


QXF Deliverable Example: Cost Implications

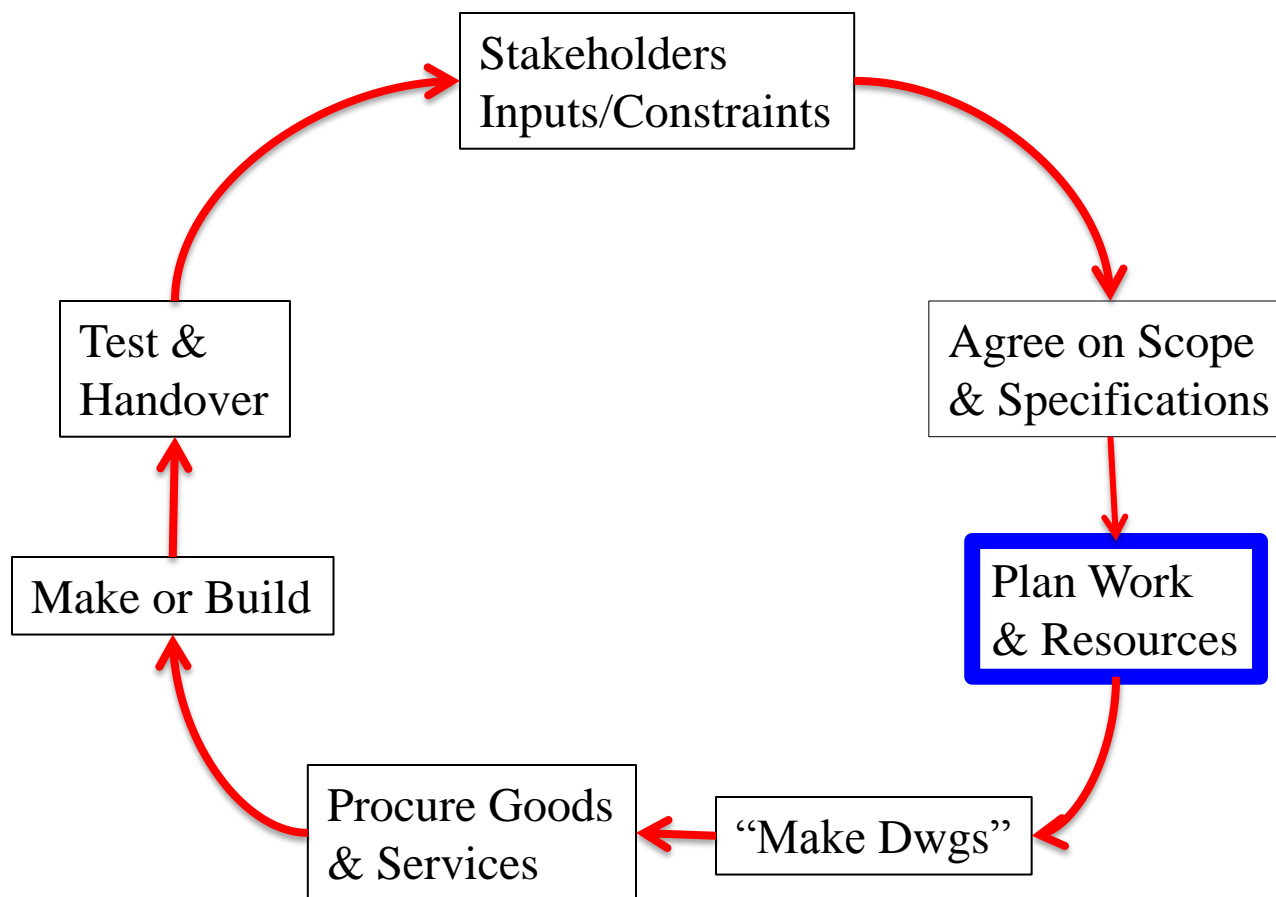
- Estimates at FNAL based on historical experiences for 9m long SS vessel (to be taken with several kgs of salt):

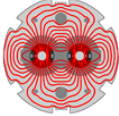
- Modification to Test Setup: ~ 2 M\$
- Test Cryostat: ~ 0.7 M\$
- Test/Operations ~ 2.5 M\$
- 10 Cold Mass Align./Weld. ~ 2.3 M\$
- Total (+/- 40%) ~ 7.5 M\$

- Naïve and simple minded exercise giving an order of magnitude.
- Scope Definition, Validation and Control (in other words, Scope Management) will be one of the few handles we have for a successful completion of the Construction Project. *This PPT ain't a scope promise !*
- Example #2: CC scope just increased by ~33% in 3rd HiLumi-LHC Meeting



Phases of (any) Project





Work Plan

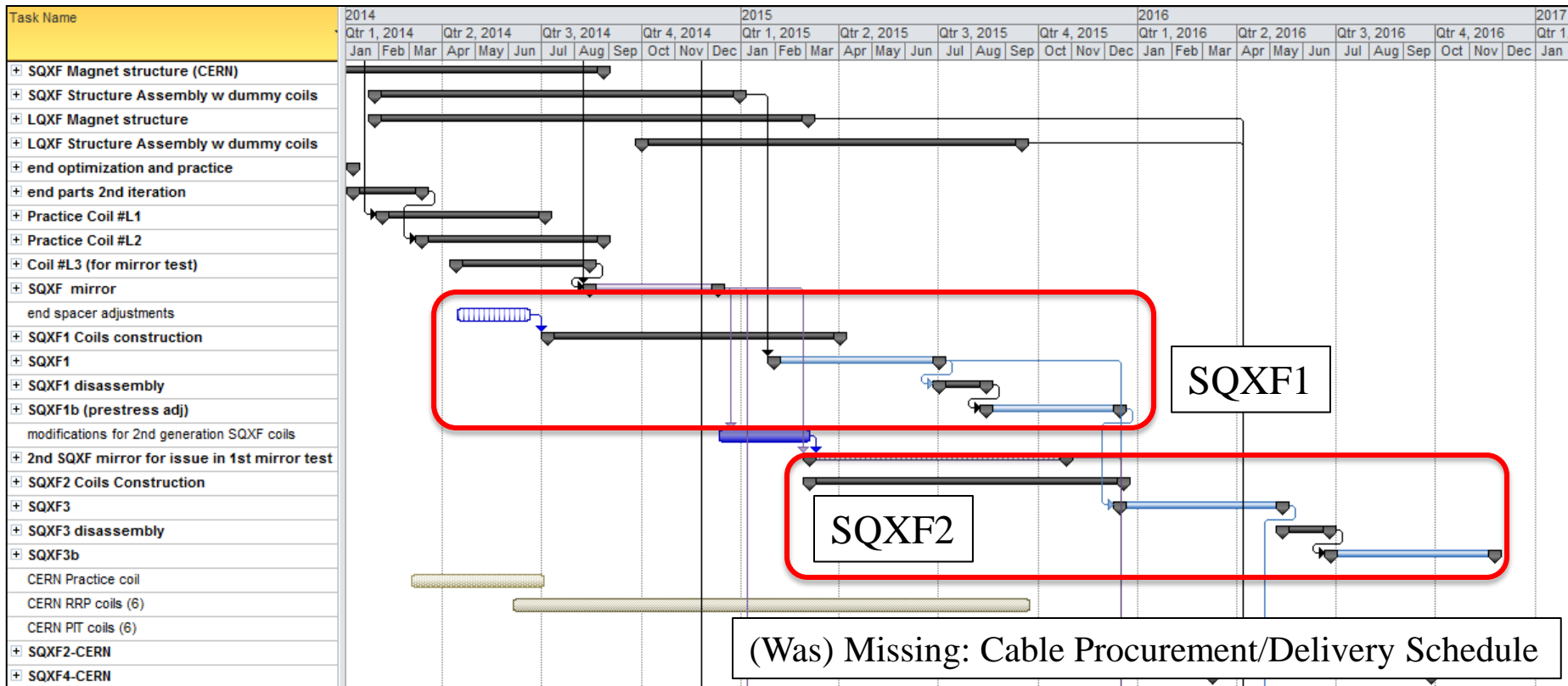
- Slowly transition from “Virtual Lab” model to “Competencies-based Lab” model
 - Core competencies relied upon to permit cost savings for the project execution phase
 - “Virtual Lab” legacy is the realization that there is hardly a “Sole Source” when it comes to HL-LHC deliverables for QXF
- Core competencies 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
 - LBL: Mechanical Structure, Cabling and Conductor
 - CC
 - LBL/ODU/BNL/FNAL: Cavities
 - FNAL: Cryostat
 - WBFS
 - SLAC

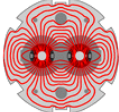


QXF Plan within LARP



(plan the work – get “go ahead” – work the plan)

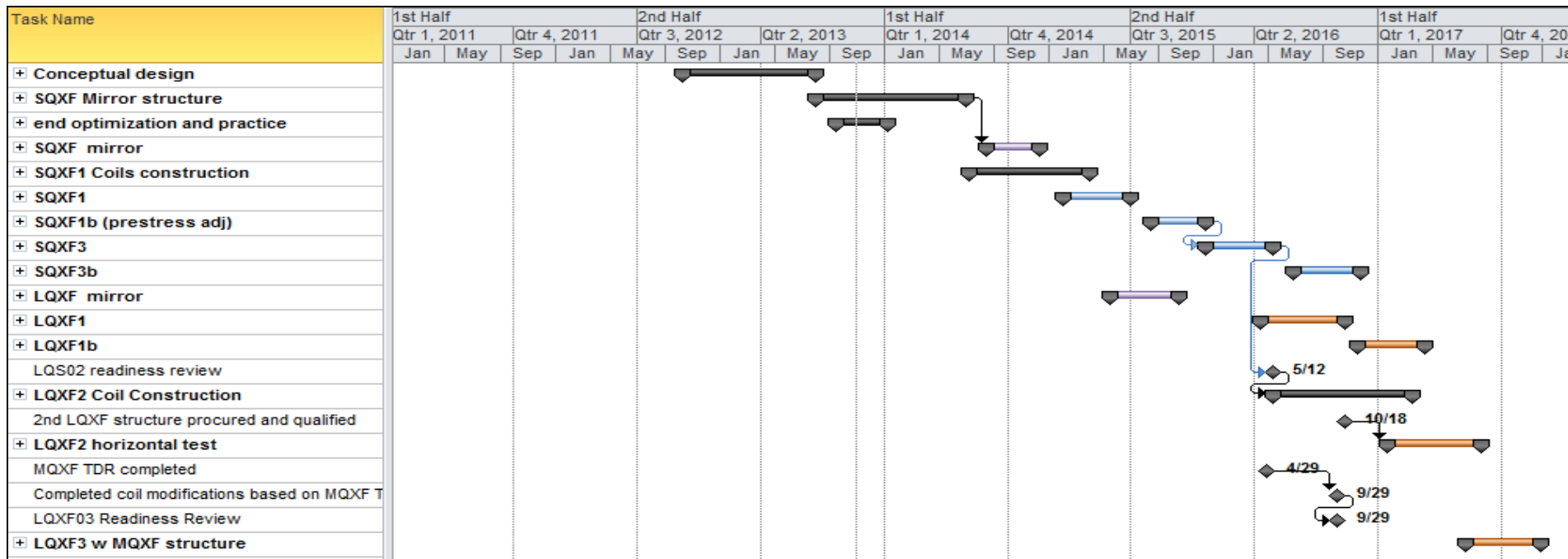




QXF Plan within LARP

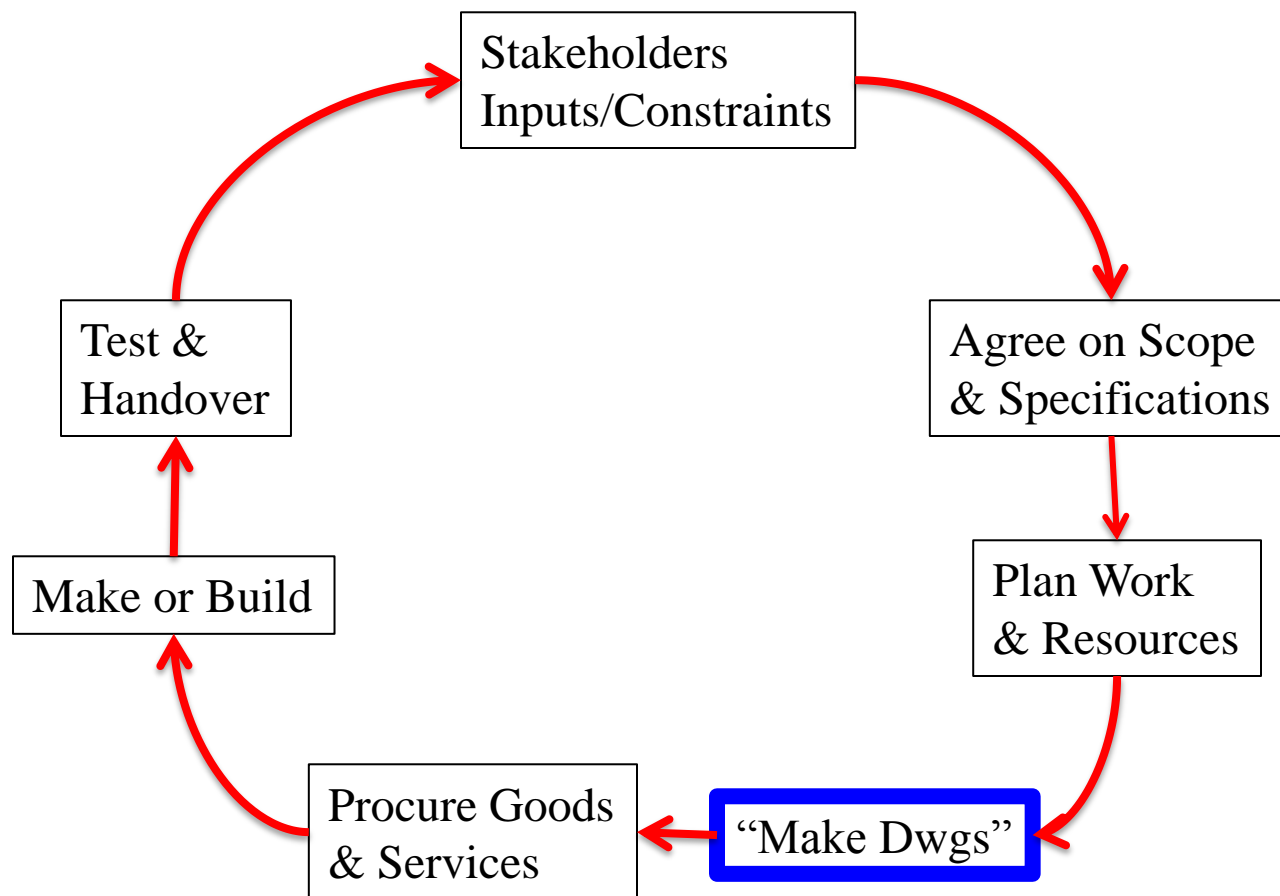


(plan the work – get “go ahead” – work the plan)



- Is detail OK for day-to-day (or week-to-week) progressing ?
 - Very few milestones, all happening toward the end of the LARP phase
- Is plan flexible and easy to change ?
 - In principle yes. Just change the dates and funding. Obvious problems with multi-lab structure (and funding transfer, if needed).
- Does the plan highlight priorities ?
 - (L)HQ tasks still in the plan. Need to highlight the feed-back on QXF risk-reduction.

Phases of (any) Project





Engineering Practices



- LHC-Triplet Incidents:
 - Failed structural support in US Magnets (Mar. '07)

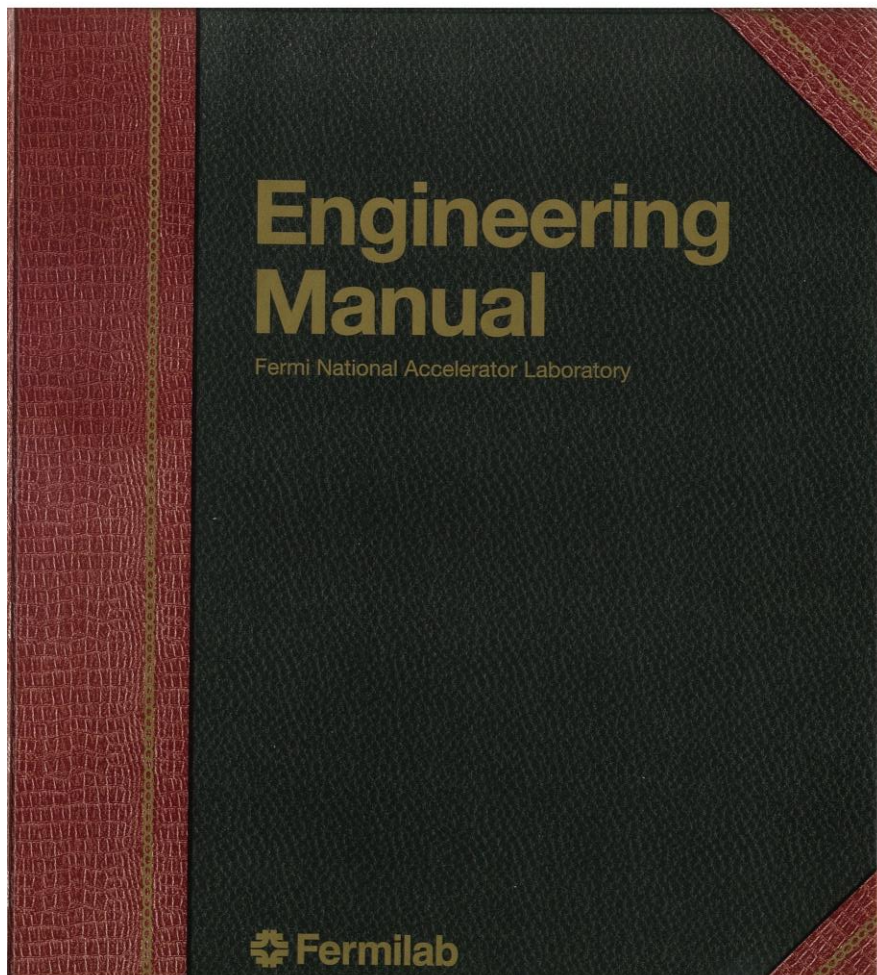


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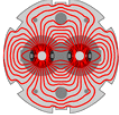
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Pressure Vessels Standards



- 3.9 GHz cryomodule for DESY:
 - ASME code used for Pressure Vessel Certification in ~2008
 - European PED/ UK PER
 - ICS (Isabel's presentation)





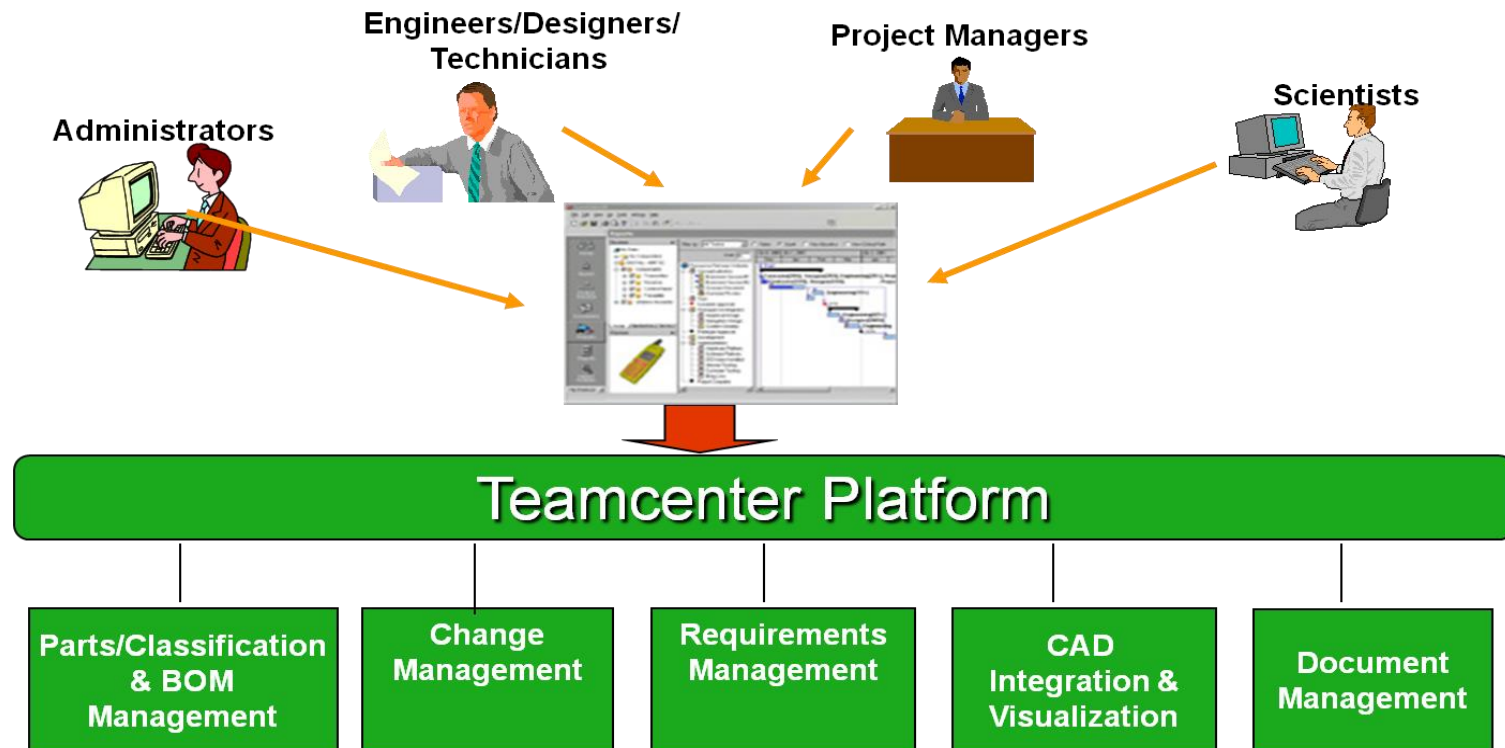
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TeamCenter

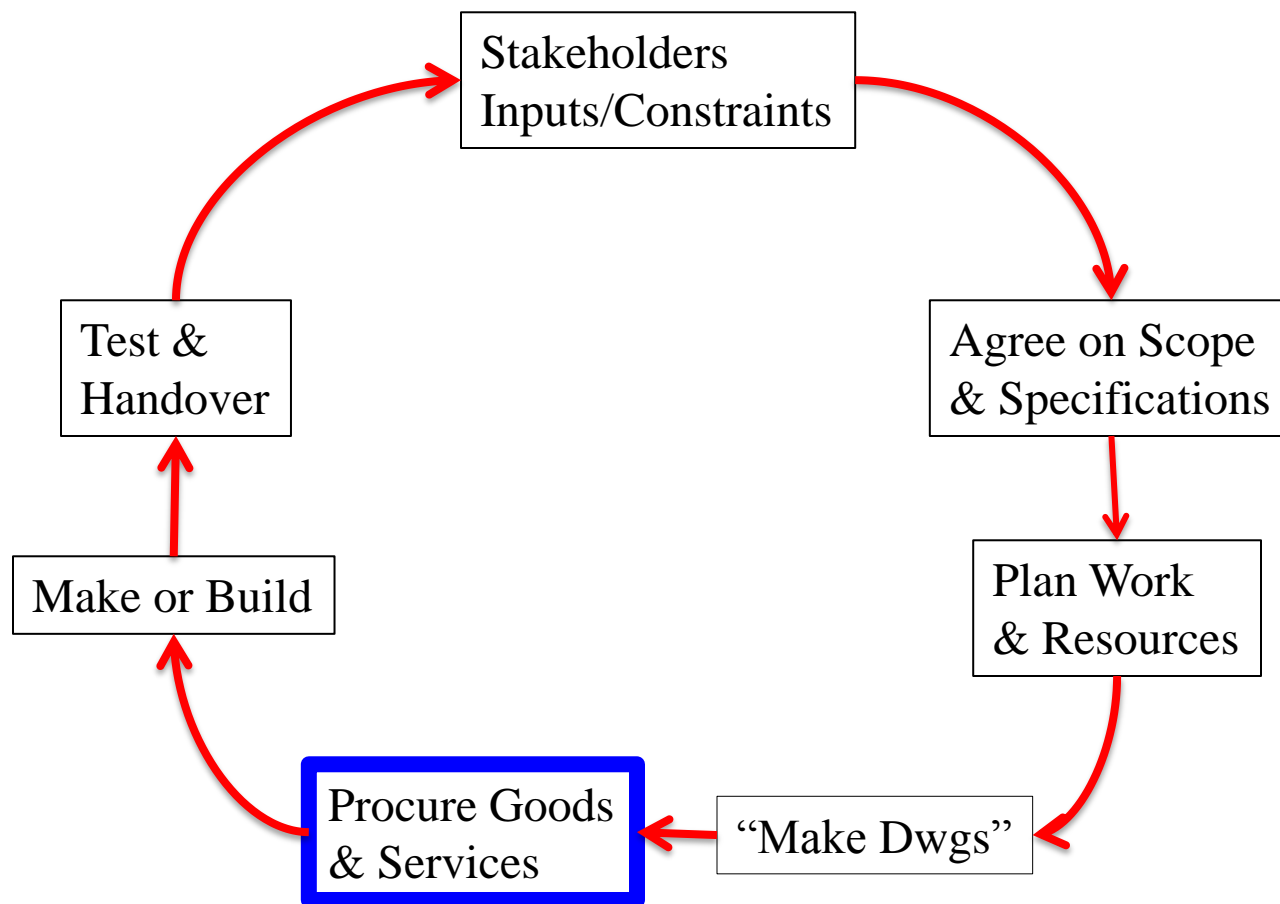


Engineering Database Management System

- **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**



Phases of (any) Project



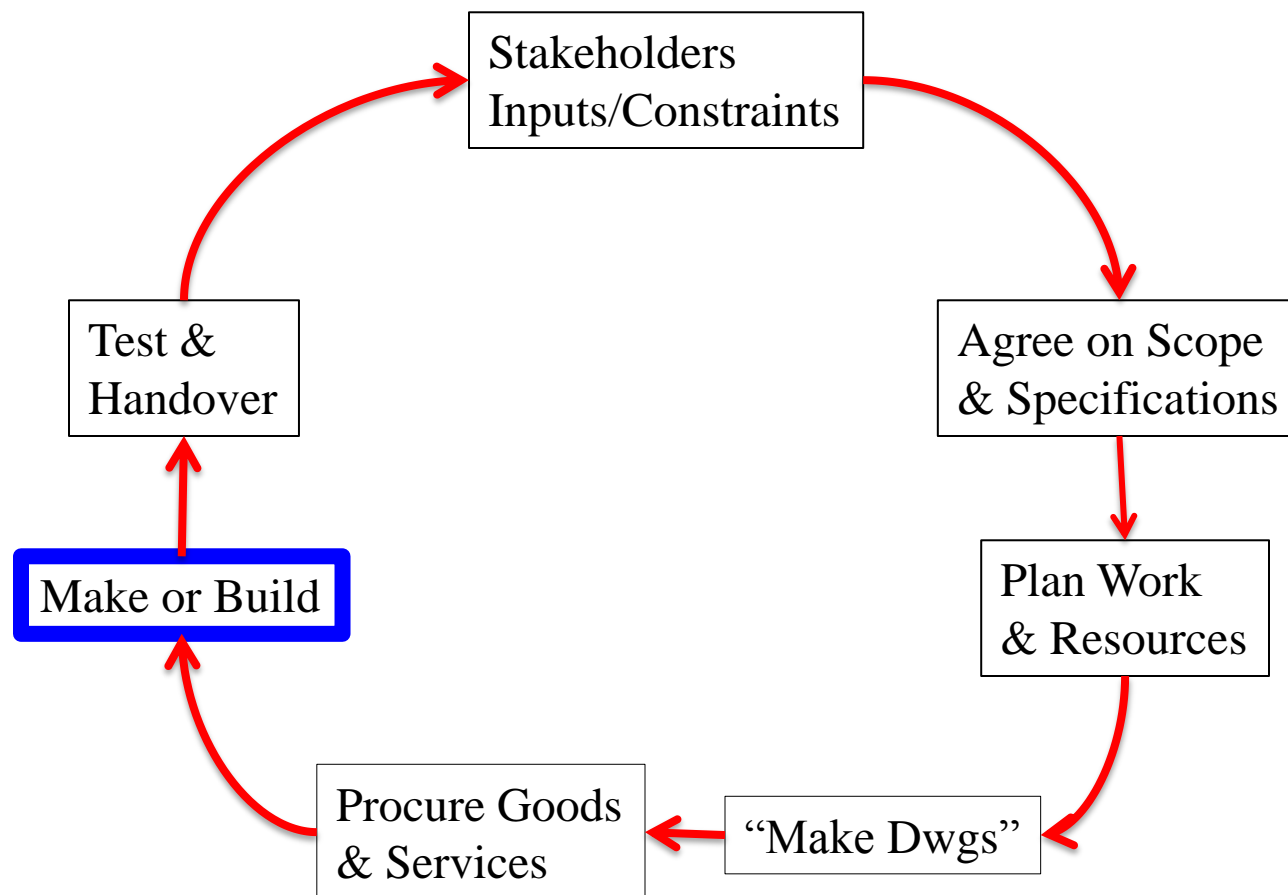


Ex: Procurement Plans



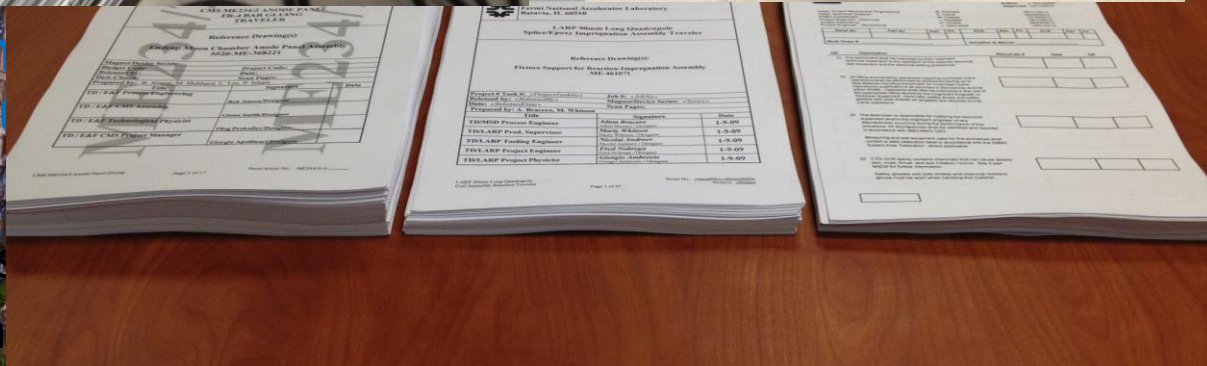
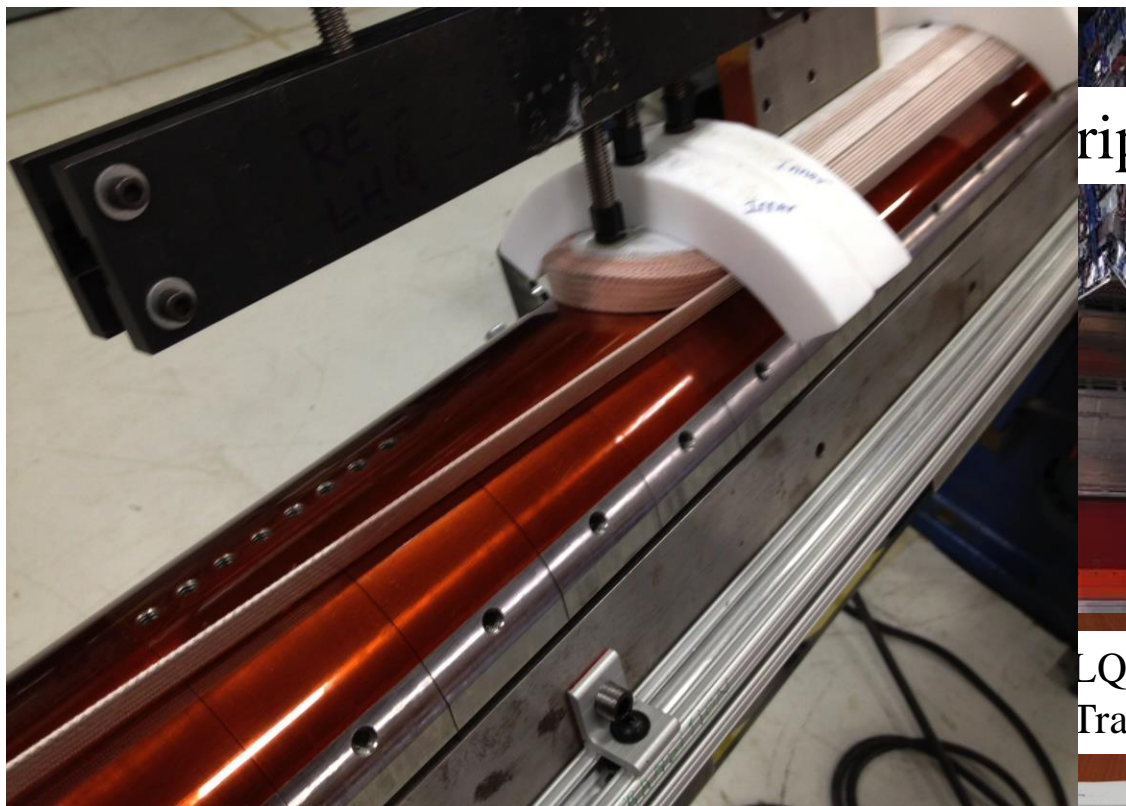
- Make full use of Organizational Assets (i.e. Procurement Departments in various Labs)
 - Specs
 - Make-or-buy
 - Vendor Conferences
 - Bids Evaluation (not only \$)
 - Vendor Oversights, Inspection and Audits
 - QC
- Big Gorilla in the room: some form of Nb₃Sn strand procurement order (~several M\$) 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 '14

Phases of (any) Project

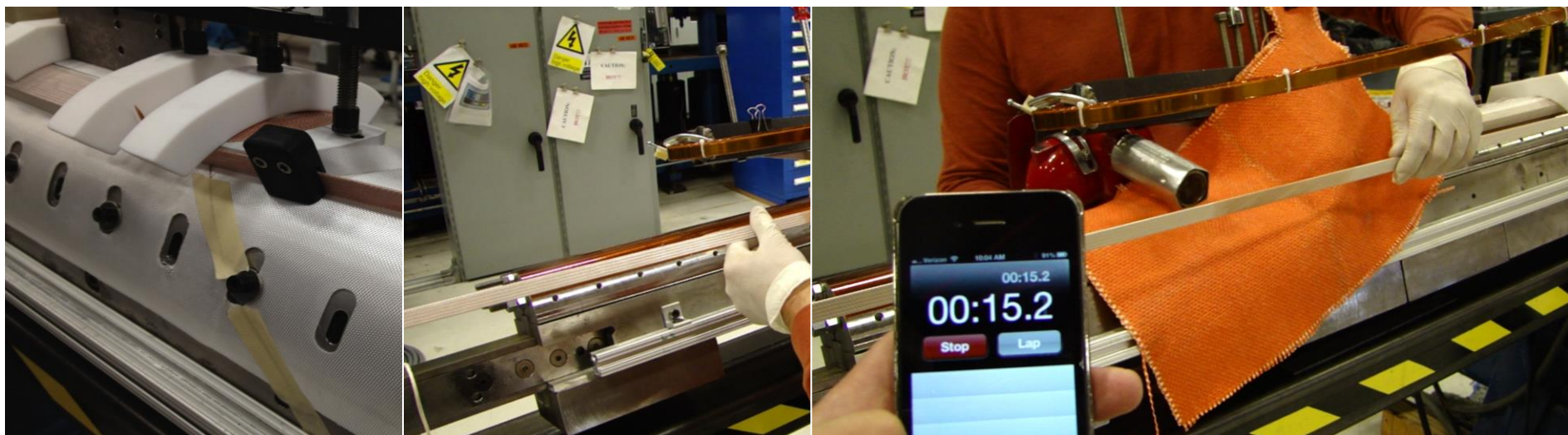




Assembly Procedures/Travelers



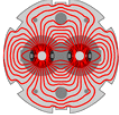
- Vital to capture in LARP in the last 12 months
- Coil Making
- Reaction Process
- Structure Assembly
- Etc.



- Plastic block and Ceramic binder to avoid popped strands during LHQ/QXF cable winding:
 - 5 min/turn x 100 turns/coil x 4 coils/mag x 20 mag. (US) = ~ 670 h
 - 670 h of touch-labor effort is measured in “~dozen(s) of k\$/kChF”.

Decision not to start a new pop-less cable development within LARP for the HL-LHC IR Upgrade appears to be a very simple one.

 - Of course different strategy needed if magnets are 10^3 or 10^4



“Project-Driven” Reviews/Workshops & Decisions

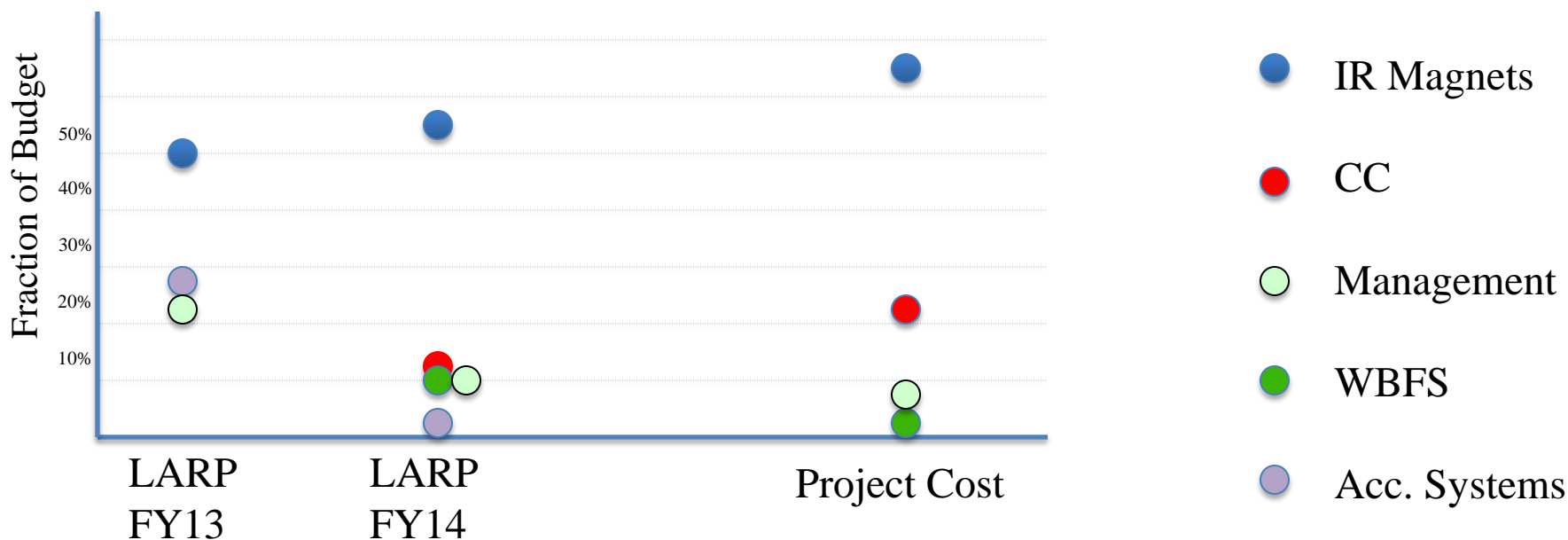
- Intentions:
 - Limit spectrum of future Development with Internal and External Reviews.
 - Eliminate R&D phase space, without excluding possibility of optimization if the chance presents itself.
 - Define rational baselines.
- Of course decisions can be reconsidered if a road-block is encountered !
- Plans:
 - Magnets
 - Conductor/Cable Review *Started*
 - Testing Infrastructure *Starting*
 - QP/Coil Design Review *Soon*
 - Magnet Design Review
 - Mechanical Structure Design Review
 - Interface(s) Review
 - Crab Cavities
 - Cavity Down-selection after SPS
 - Cavity Services (PC, Tuning scheme, He Vessel..)
 - SPS CryoM & LHC CryoM
 - ...
 - Feedback System
 - SPS vs LHC Functionality Review
 -



FY14 LARP Funding



- In June '13 the LARP Collaboration prepared plans for FY14 under a guidance of ~12.6 M\$ excluding GARD contributions (~2-3 M\$ range). The expected FY14 funding was ~14.6-15.6 M\$
 - GARD=General Accelerator R&D, program in US Labs and Universities covering basic Accelerator R&D, a.k.a. "Core Program".
- In July '13, DOE communicated that LARP IFP for FY14 would be 12.4 M\$ inclusive of a 2M\$ GARD contribution. A funding increase in FY15-FY17 will represent a challenge.





LARP

LARP “Good Intentions”



	“Wish List” in June ‘13 for LARP funding in FY14-FY17	Expected Funding if FY15- FY17 Budget continues at FY14 IFP levels.
Magnets	~28 M\$	~25 M\$
CC	~8 M\$	~5 M\$
WBFS	~7 M\$	~5 M\$

- It is in our highest common interest to use LARP to facilitate the HL-LHC upgrades within available funds and resources
- However, LARP is not a project and scope/deliverables are not negotiated and/or endorsed by the funding agencies/Labs
- The previous comments effects SPS Studies post-LS2 and specifically the tests for Crab Cavities and the WBFS
- Redefinition of post-LS2 studies in the SPS and expectations in terms of LARP contributions is needed as a function of LARP funding.
- DOE LARP Review in Feb ‘14 will be chance to plea for funding removed in FY14 IFP.



DOE "Projectization"

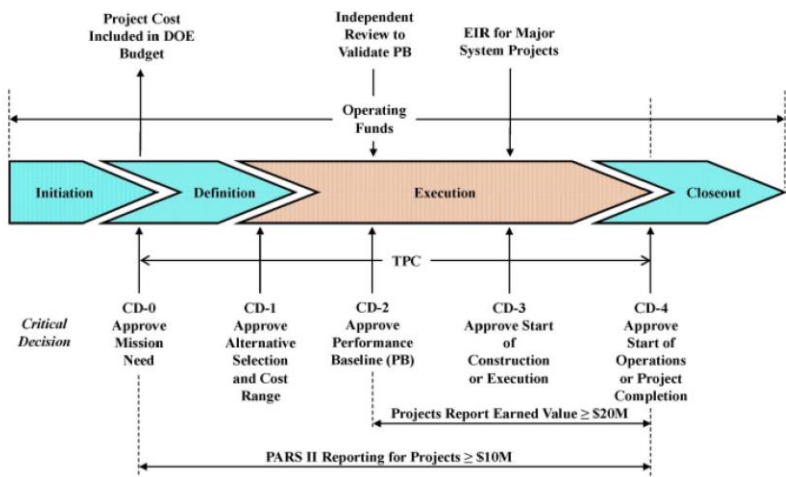


Figure 2. Typical DOE Acquisition Management System for Other Capital Asset Projects (i.e., Major Items of Equipment and Operating Expense Projects)

Table 1. Critical Decision Authority Thresholds

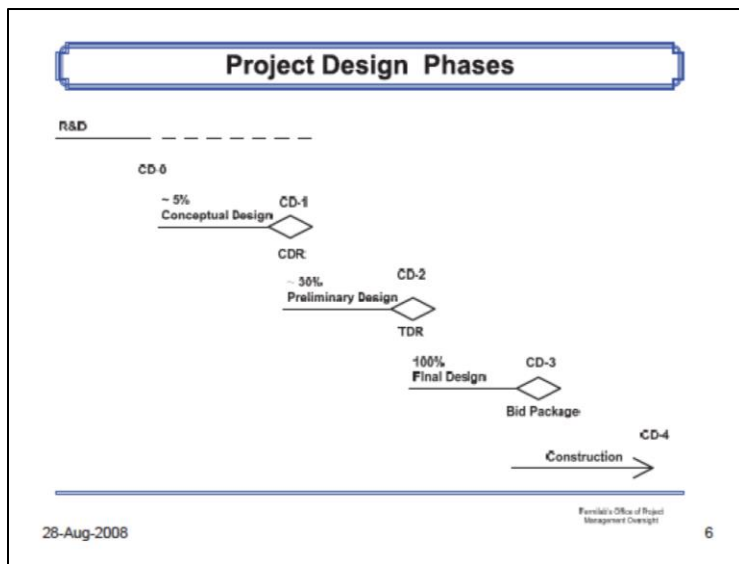
Critical Decision Authority	Total Project Cost Thresholds
Secretarial Acquisition Executive	<p>≥ \$750M</p> <p>(or any project on an exception basis when designated by the SAE)</p> <p>Further delegation is allowed.</p>
Under Secretaries	<p>≥ \$100M and < \$750M</p> <p>(or any project on an exception basis when designated by the Under Secretaries)</p> <p>Further delegation is allowed.</p>
Program Secretarial Officer	<p>≥ \$50M and < \$100M</p> <p>Further delegation is allowed.</p>

Possible Scenarios

- “Collapsed” approval process where several CD are granted at the same time
- Use of CD3a process for long-lead time procurement (Nb₃Sn, Nb, etc.)
- Working back from CD-4 (delivery on CERN dock of Cold Mass #10) in mid-late 21, CD-3 needed around '17.
 - Cold Mass #8 available at CERN by beginning '21
- With construction starting in FY17/18, we need to converge for CD3 in a very short amount of time.



Design and DOE CD phases



From E. Temple:
General Project Management

- Plan for CD0/CD1/CD2 in early-FY16, CD3 in late FY16 ?
 - Preparation for for CD0/1/2 by early FY16 will require set of relatively formal “Ghost Director Reviews” to be started almost immediately in FY14.
- Need to be prepared to reality that PED funds, typically allocated after CD1 in US, will not be available for HL-LHC
 - LARP needs to complete prototyping !

	CD-0	CD-1	CD-2	CD-3	CD-4
Mission Need Statement (MNS) (approved)	X				
High Level Project Parameters	X				
Rough Order of Magnitude (ROM) Cost Estimate	X				
Schedule Estimates	X				
Program Requirements Document (for NNSA only)	X				
Develop Project Data Sheet (PDS)	X				
Acquisition Strategy (AS) (approved)		X			
Preliminary Project Execution Plan (PEP) (approved)		X			
Tailoring Strategy, if required, (could be part of the PEP)		X			
Risk Management Plan (could be part of the PEP)		X			
Conceptual Design Report		X			
Preliminary Hazard Analysis Report		X			
Integrated Safety Management Plan		X			
Quality Assurance Program (QAP)		X			
Identify Safeguards and Security requirements		X			
Complete a NEPA Strategy		X			
Prepare and Environmental Compliance Strategy		X			
Update Project Data Sheet (PDS)		X			
Performance Baseline (PB)			X		
Updated Acquisition Strategy (AS) (approved)			X		
Updated Project Execution Plan (PEP) (approved)			X		
Project Management Plan (if applicable)			X		
Preliminary Design Report			X		
Project Definition Rating Index Analysis			X		
Technical Maturation Plan			X		
Hazard Analysis Report			X		
Preliminary Security Vulnerability Assessment			X		
Final NEPA Determination (Environmental Impact Statement)			X		
Update Project Data Sheet (PDS)			X		

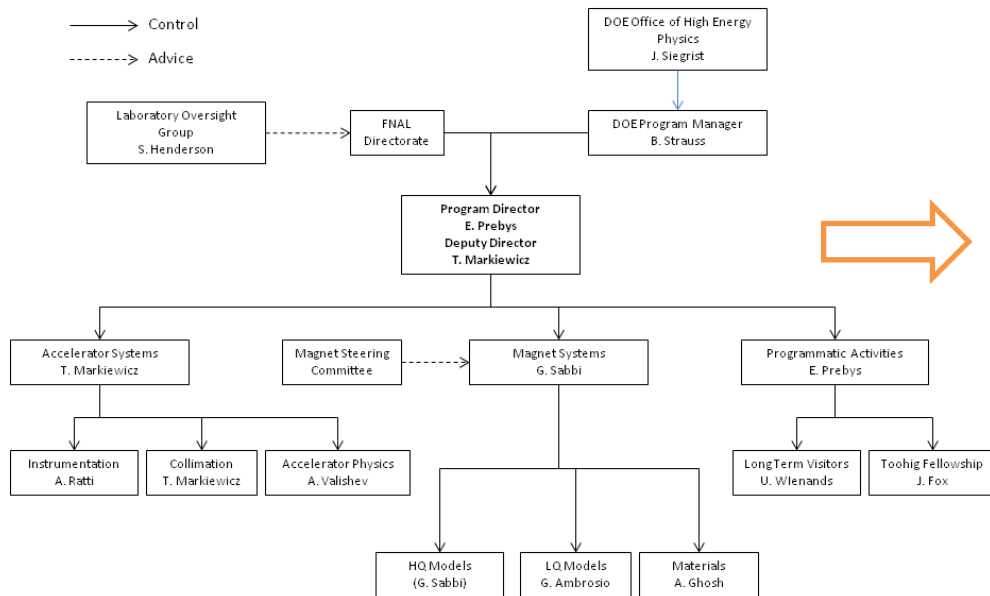


Project Organization Structure

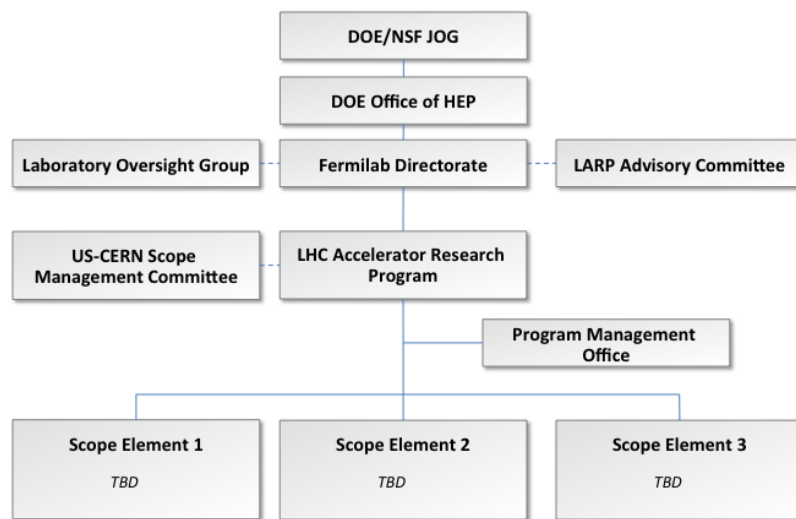


LARP Organization Chart

December 13, 2011



Proposed LARP Organization





Next HL-LHC/LARP CC



- Next HL-LHC/LARP Collaboration Meeting on May 7th-9th, 2014
 - 22nd LARP CM
 - Wednesday to Friday Meeting.
 - Use Monday/Tuesday for satellite workshops & meetings as needed
 - 2 or 3 parallel WP ?
- Likely Venue: Brookhaven National Laboratory
- Website info to come in near future

Conclusions

- Huge amount of knowledge within LARP needs to be fully captured and documented in the next ~ 3 years to hit the road running on the HL-LHC project.
- Shifting from R&D to “Projectized” mentality by introducing some formality in our actions and aligning our activities along rational baselines and deliverables
- Work on the definition of Magnets, CC and WBFS activities in terms of expected LS2-contributions with fall-back plans should the LARP funding fall short of expectations.
- Either as US-LARP or as US-LARRP (LHC Acc. Risk Reduction Program), our collaboration is a premium partnership for a successful HL-LHC Upgrade.