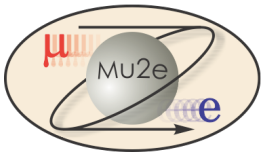
Fermilab

U.S. DEPARTMENT OF ENERGY Office of Science

Lessons Learned from Other Projects



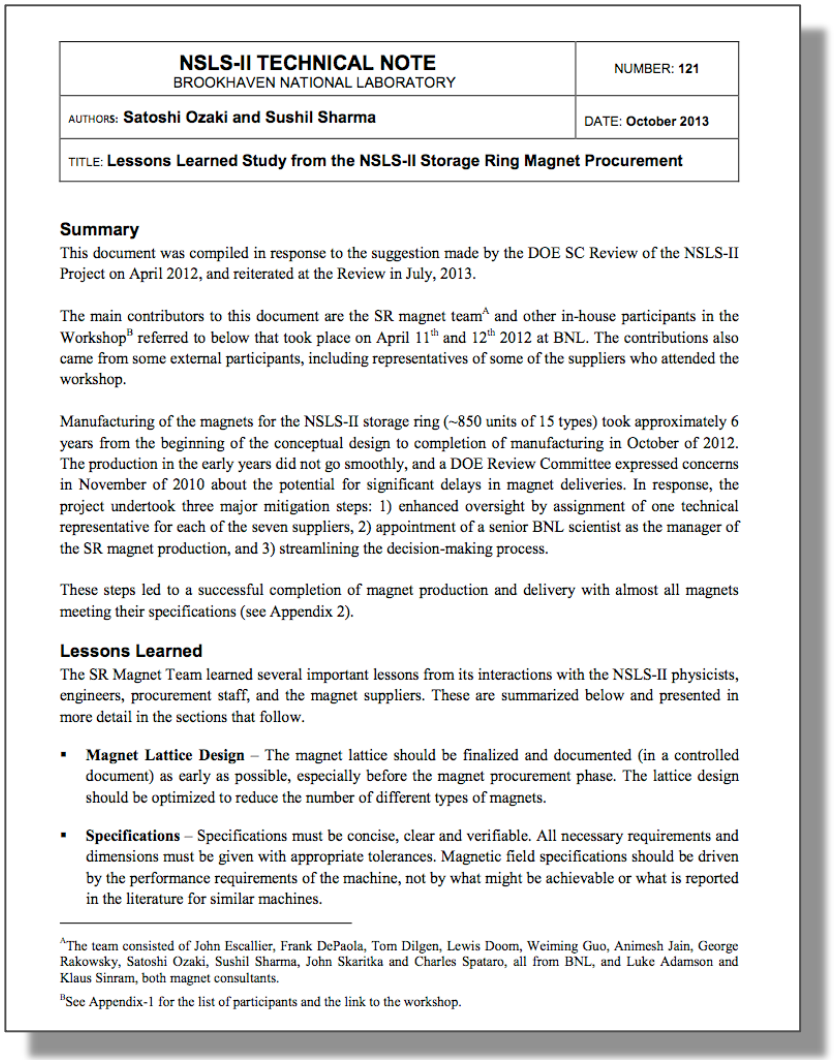
R. Ray
Mu2e Project Manager
7/8/2014

Lessons learned come from many places

- Lots of people and projects out there with relevant experience
- We understand this at Fermilab and have put some formal and informal mechanisms in place to try and benefit from the experience of others.
- Project Manager Lunches – Project Managers have lunch together once a month to compare notes, share experiences and complain to a sympathetic crowd
- POG meetings – Formal meetings of PM community with Directorate and Line Management to keep everyone on the same page, to share experiences between projects, resolve resource issues, etc. PMs, line managers and Directorate all benefit from these exchanges.

Magnets

- Lots of people design and build magnets across the DOE complex.
- Some procurements have been more successful than others.
- We have incorporated lessons learned from NSLS-II, Jlab, LHC IR quads, PNNL and our own solenoid conductor procurements into our acquisition strategy.
- Solenoid Acquisition Oversight Committee provides us with lots of good advice.



NSLS-II TECHNICAL NOTE BROOKHAVEN NATIONAL LABORATORY	NUMBER: 121
AUTHORS: Satoshi Ozaki and Sushil Sharma	DATE: October 2013
TITLE: Lessons Learned Study from the NSLS-II Storage Ring Magnet Procurement	

Summary

This document was compiled in response to the suggestion made by the DOE SC Review of the NSLS-II Project on April 2012, and reiterated at the Review in July, 2013.

The main contributors to this document are the SR magnet team[A] and other in-house participants in the Workshop[B] referred to below that took place on April 11th and 12th 2012 at BNL. The contributions also came from some external participants, including representatives of some of the suppliers who attended the workshop.

Manufacturing of the magnets for the NSLS-II storage ring (~850 units of 15 types) took approximately 6 years from the beginning of the conceptual design to completion of manufacturing in October of 2012. The production in the early years did not go smoothly, and a DOE Review Committee expressed concerns in November of 2010 about the potential for significant delays in magnet deliveries. In response, the project undertook three major mitigation steps: 1) enhanced oversight by assignment of one technical representative for each of the seven suppliers, 2) appointment of a senior BNL scientist as the manager of the SR magnet production, and 3) streamlining the decision-making process.

These steps led to a successful completion of magnet production and delivery with almost all magnets meeting their specifications (see Appendix 2).

Lessons Learned

The SR Magnet Team learned several important lessons from its interactions with the NSLS-II physicists, engineers, procurement staff, and the magnet suppliers. These are summarized below and presented in more detail in the sections that follow.

- **Magnet Lattice Design** – The magnet lattice should be finalized and documented (in a controlled document) as early as possible, especially before the magnet procurement phase. The lattice design should be optimized to reduce the number of different types of magnets.
- **Specifications** – Specifications must be concise, clear and verifiable. All necessary requirements and dimensions must be given with appropriate tolerances. Magnetic field specifications should be driven by the performance requirements of the machine, not by what might be achievable or what is reported in the literature for similar machines.

[A]The team consisted of John Escallier, Frank DePaola, Tom Dilgen, Lewis Doom, Weiming Guo, Animesh Jain, George Rakowsky, Satoshi Ozaki, Sushil Sharma, John Skaritka and Charles Spataro, all from BNL, and Luke Adamson and Klaus Sinram, both magnet consultants.

[B]See Appendix-1 for the list of participants and the link to the workshop.

Magnet Lessons Learned

- Order conductor as soon as possible – CD-3a
- Finalizing the requirements as early as possible
  - Solenoid requirements in place for 2 years.
- Concise, well-defined specifications with adequate margin and attainable tolerances
  - Review of tolerances and specifications with AOC over the past year.
- Vendor schedules tend to be aggressive
  - Add float to vendor schedules. Add time for design reviews and hold points.
- Vendors often accept reference designs without any internal analysis
  - Communication
- Regular monitoring of vendors and presence at production facility is critical
  - Planning on bi-weekly phone calls and quarterly site visits
  - More significant presence during critical fabrication phases.
  - In-process QA

Magnet Lessons Learned

- My own lesson learned based on observing the extensive and very successful QA process applied to the R&D quantities of superconducting cable we procured over the past year.
  - Dedicated, hard working people make things work.
  - Vito Lombardo ran the QA program for the solenoid conductor. It took a large fraction of his time. He made site visits, had regular phone calls with vendors, enforced hold points, ran meetings.
  - That kind of effort is required, even for things significantly less complicated than superconducting cable.

Lessons Learned from NOvA

- As NOvA approaches CD-4 they are a treasure trove of lessons learned on many fonts.
- Bill Freeman and Suzanne Saxer were the Project Controls and Financial leads on NOvA
- Suzanne is working with us and others on interfacing with COBRA.
- Bill has been meeting with our Project Controls team to pass on his lessons learned.
  - For example, don't baseline on early dates. More than half of NOvA's change requests were the result of doing this.

Accelerator Lessons Learned from NOvA

- Extended presentation from Paul Derwent, ANU L2 Manager
- Participation in a working group chaired by Vaia Papadimitriou for the purpose of determining what lessons could be learned from the NOvA/ANU project experience.
- The contributors (speakers and other participants) include:

Phil Adamson	Mike Andrews	Rich Andrews	Paul Derwent
Patrick Hurh	Cons Gattuso	Jim Hylen	Chris Jensen
Phil Schlabach	Salman Tariq	Linda Valerio	Karl Williamson

- What follows has been pulled from a PMG presentation by Steve Werkema last October.

Cost & Labor Estimation

- ANU labor was underestimated by 15 – 20% across all resource types. General reasons for this include:
  - Necessary scope not completely identified when schedule was constructed (e.g. resources and time for procurement/fabrication not added to schedule)
  - Incomplete understanding of tasks at the time labor estimates were made (e.g. engineering oversight effort)
  - Underestimates of effort required for specific task categories (e.g. drafting requirements underestimated by as much as 60%)
  - Changes in requirements after initial cost estimates (e.g. mechanical tech labor underestimated for vacuum preparation of components because vacuum requirement was not specified at the time of the estimate)
  - Unforeseen technical problems (e.g. RF cavities)

Cost & Labor Estimation (specifics)

- Project management labor (~20% – 30% overhead per CAM)
  - Weekly checking/correcting FTL charges
  - Monthly reporting
  - Schedule management
  - Cost review/update
  - This effort should be accounted for in the project schedule
- Designer/Drafter labor
  - Salman Tariq rule of thumb: Expect Designer/Drafter to Engineer ratio between 2:1 and 3:1
  - Note: since much of the installation in which Salman was involved was in a high radiation area (greater need for drawings) this estimate is likely a bit high for Mu2e tasks

Cost & Labor Estimation (specifics)

- Engineering oversight effort
  - Engineering oversight effort not included in initial ANU estimates
  - Engineering oversight resources were added by project manager (Paul Derwent) after initial ANU schedule construction
  - Patrick Hurh recommendation: Add M&S to engineering oversight activities to cover costs of tool replacement and miscellaneous items
- ANU applied a 140% factor to the estimated baseline cost for installation to cover: learning curve, variations in experience/motivation of tech.'s, etc.
- Schedule changes, changes to requirements, market changes, changes to the resource pool, and many other things impact costs
- Cost estimates must be periodically re-assessed

Cost & Labor Estimation Recommendations

Cost estimating (labor estimating) is an activity whose importance is underappreciated. Big mistakes can be made here.

- Qualified staff should be involved in cost estimating as early as possible – this activity requires much more attention than it usually gets.
- Cost estimating is a skill that should be developed and cultivated at Fermilab
- Labor estimates should not assume the best qualified personnel will be performing the work – include learning curve effort in labor estimates.
- Do not assume the best possible scenario. Use 85% C.L. estimates.
- Active Cost Management: All cost estimates should be reviewed and updated periodically by qualified staff. Will be included in ETC forecasts.
- Mu2e does all of these (with help from the lab on the second item)

FTL Issues

- Misunderstanding of (or inattention to) an agreement with AD/Instrumentation regarding division of ANU labor charges led to significant difficulties with improper FTL charges.
- Observation: Tech's don't care about accurate labor charging (My personal observation: tech's are not the only offenders)
- Observation: Whole days or half days of effort are charged for work that takes only an hour or two
- Observation: Very unlikely people will spend time finding a new charge code for which to charge their time after starting a new task (they'll use a code that already shows up on their pick list)
- Consequence: project management expends a large amount of effort correcting improper FTL charges

FTL Recommendations

- Project management must frequently and repeatedly make clear what codes are to be charged for the work they manage
- Review of charged effort should happen as close (in time) to the job as possible
- Use the fewest number of task codes possible
- VERY IMPORTANT: close codes when a task is complete – otherwise they will accumulate erroneous charges over time.

Mu2e does all of these. Weekly FTL charges are distributed to L2 managers and CAMs for review.

Schedule Issues

- ANU schedule initially built using early dates – everything was entered to be completed as soon as possible
- Initial ANU schedule not constrained by resource availability (prior to CD-3)
- Problems incurred because schedule was baselined too early (in the view of more than one manager)
- Spares: Cost savings can be realized if spares are built at same time as project funded components and purchased from project by the lab. *This must be built into the schedule and plans for funding must be made.*

Schedule Issues (cont.)

- Ownership of the schedule
  - At management level 3 and below there is limited access to the schedule – pdf and EXCEL copies of schedule
  - At level 3 and below, access to resource information is only available through BOEs (not the schedule); dependency information not available
  - Project management at all levels and the engineers supervising the work need access to the full schedule (including the schedule logic and dependencies)

Schedule Recommendations & Comments

- Level schedule prior to baselining
  - we plan to do this, but we need a funding profile
- Incorporate resource availability constraints (to the extent that they are known) into the schedule prior to baselining
  - We will do this to the extent possible, with some help from division management
- The schedule (activities, dates, dependencies, and resources) must be available at all levels of the project organization.
  - Fermilab is working on development of a CAM notebook tool that will provide CAMs with easy access to information in P6