NSLS-II Beamline Controls Group Review

1. Introduction

NSLS-II management has instituted an external review of NSLS-II beamlines controls. This covers the technical areas of beamlines controls, motion and EPS, and took place on the 31st January 2018. The review was made up of presentations by, and discussion sessions with NSLS-II staff. The committee presents their views as findings, comments and recommendations in response to each of the charge questions, together with overall comments and recommendations. This report was written and edited by all committee members and committee members agree unanimously on the contents of this report.

The committee was impressed by the willingness of NSLS-II staff to engage in the process. The openness of the discussions enabled the committee to gain insight into the functioning of the Controls Group and the achievement in delivering NSLS-II. The committee highly commends the Controls Group for their commitment and the solutions and services they have provided to the NSLS-II Beamlines.

A number of the committee considered many of their concerns were similar to the "growing pains" other facilities have encountered, either when undergoing a transition from construction to operations or (at the APS) when bringing previously independent beamlines under facility management. The NSLS-II is a complex facility; transition to operations is not a trivial task.

In considering the recommendations of this report, the reader should take them in the context of the review. Any recommendation is based on the limited insight one can achieve within a single day review. In order to avoid any misunderstandings or over-interpretation of the recommendations, the committee is willing to provide clarification should it be needed.

2. Are Beamlines controls appropriately staffed and managed?

Consider – Levels of staffing, areas covered, responsibilities clear, other groups

Findings:

Beamline controls staff lack a clear sense of priorities and though they are strongly motivated to support the facility, inefficiencies exist which should be addressed.

The group is weak (under-staffed) in terms of core EPICS/software talent. It appears only one staff member, supporting NSLS-II at 80% FTE-equivalent, has the competency to advance the facility in terms of extending capabilities.

The Beamline Controls group has experienced significant attrition as beamline construction has rolled off into science operations.

The various staff groups do not appear to be well aligned in terms of both communication and priorities.

There appears to be a communication barrier between senior management and line-staff. Beamline controls staff do not value certain all-hands meetings and do not appear to understand facility goals. They are unable to connect the strategic vision of the facility management to their day-to-day activities.

Comments:

Staff-attrition, priority-confusion, and resulting morale issues are a natural consequence of the necessary cultural shift in the transition from construction into operations of a new facility. Clearly, management is aware of some of these issues and they should be closely managed.

Staff vacancies present an opportunity to onboard operations-minded personnel.

Management appears to lack a coherent strategy for transitioning the team from project work into a sustaining operating model.

Benchmarking against other facilities is difficult and may be of limited use because of the different organizational structures and different metrics used by different facilities. However, the level of Controls staff (IT, Beamline Controls, Motion Controls) seems roughly similar to other US light sources.

The allocations within this overall area may be out of balance. IT for example is probably light. The skills mix within the Beamline Controls group may need some consideration.

While there seem to be many staff dedicated to motion control, it seems that some important "deep" expertise has been lost. We heard complaints from beamline staff that there were delays in axis integration. We also heard that they found re-tuning motors was necessary and time consuming.

There was also limited staff and experience in supporting control and readout of detectors. This is a technical area that is increasingly important in developing instrument capabilities but one that presents significant challenges at the software level; so needs to be resource with the "right" skills set.

Responsibilities within the group seemed to be reasonably clear to most group members, but not to some beamline staff.

Some functions that appear to be within the remit of the beamlines controls group were reported as being carried out by the DAMA group. The DAMA group seem to be the de-facto system integrators.

The controls effort has adequate and dedicated management. Though groups newly formed in a reorganization may need a lead assigned, this may present a development opportunity for an internal expert. Controls staff (and others including IT and DAMA) lack a clear sense of priority to

guide their day-to-day activities toward strategic facility goals. Members of the teams derive little value from Controls all-hands meetings, through lack of attendance or attention.

The various staff groups do not appear to be well aligned in terms of both communication and priorities. There is a perceived lack of vision among the management team – we heard that Controls all-hands meetings are non-existent – these can be extremely effective in communicating strategy, vision, celebrating successes, and introducing new staff – i.e. tying the facility together with a greater sense of community and purpose. Senior management, working with line management, need to perform an exercise in analyzing operations needs and making projections to inform a sustainable staffing model.

Recommendations:

Management should seek to bolster the talent-pool in core EPICS/software development, and motion support, through training and development or by replacing recent departures in this area. Consider formation of a controls software development/'tools' group, or team, to support new devices, feature requests, new tools, etc.

Management should explore and implement talent-retention strategies. Consider providing public recognition of accomplishments, and opportunities for training, and conference-travel.

Explore opportunities to engage the technical staff in embracing and advancing facility goals. Remove barriers including the noise associated with competing requests that prevent staff from focusing and completing objectives efficiently (decision fatigue.) This can be helped by clear, well-defined and enforced priorities, stronger use of the centralized request mechanism, and assigning task queues aligned with priorities.

Management should reassess whether the staffing model is optimum to meet the stated objectives of NSLS II being a world leading facility, and to sustain operations as project work draws to a close.

3. Are the Point of contact and issues tracking systems adequate?

Findings:

The Point of Contact POC system allocates one Controls group member to be a contact between the Controls group and a beamline. The intent is to improve communications between the group and beamline.

The POC system seems to be inconsistently executed. Some beamline scientists were satisfied with their POC (or had been before the individual left the facility) whilst others were unhappy. Complaints included the POC not being familiar with the beamline, the POC not wanting to be engaged and the POC hindering communications.

Comments:

The shift to a POC-led service model is positive as it centralizes requests and provide benefits including insulating core development staff from operations. The following points should be considered for the POC program to work well:

- The POCs will require strong management support to reinforce the importance and clarify their role across groups.
- The POCs will require strong management support to empower them in leadership roles to prioritize work and hold other staff accountable for assigned tasks.
- Management should hold consistently regular meetings to support the POCs in working through the transition (6 months – 1 year)
- The POC must have a "service" attitude to the task. This is a shift from the "construction" oriented motivation that people have been used to.
- The POC must be able to build a rapport with the scientists. Not everyone possesses this skillset. Not everyone is suited to the role.
- Beamline staff should feel the POC is part of their team and that they are aware of the issues and plans of the beamline.
- The POC should facilitate communication between *all* computing staff and the beamline. If a scientist does not know whom to contact about an issue the POC should find the correct person.
- The POC should not prevent the scientist talking directly to whomever they need to.
- The POCs should be recognized for performing an important role.
- The POCs could become the initiators of new requirements for improvement/development tasks within the constraints of pursuing facility-wide consistency and uniformity. Among them, they should negotiate compromise solutions between the beamlines which are actionable by the technical and development staff.
- The POCs could advise management on priorities gathered from their interaction with beamline scientists and facility users, and their own hands-on experience with the DAMA, IT, and Controls tools.

As the POC system matures the role of the POCs could evolve from one of enhancing communications a wider one, incorporating some of the points above.

The issue tracking system results are mixed from the beamline staffs perspective. The issue tracking system could be a useful source of data for evaluating effort requirements, tracking trends. Of course, it should also ensure issues are not forgotten and are resolved.

For the tracking system to work and be trusted it must deliver results for the scientist, otherwise why would they use it. There are cultural issues in ensuring adoption; it is a change in the way people work and will require management attention to change management.

Management should pay attention to the metrics from the system, e.g. tickets that are open for more than *n* days, average response time. These can be used to drive improvements.

Recommendations:

All levels of management should provide strong support to the POCs. This should include empowering them, ensuring the correct people are in the role and that the POCs are given the time and resources required to be successful.

4. Does it service the technical needs of the Beamlines Scientists?

Findings:

There are some lags in service of the technical needs of beamline scientists, with recognition that there are very few engineers to fulfill this service.

Motion control appears to demand a concerning amount of time and effort, and requires significant expertise. Perhaps due to staff attrition, beamlines are not having all axes implemented in a timely fashion (expertise may be lacking and additional training required).

Integration of new detectors was another specific area of frustration. The DAMA efforts have been very well-received, however GUI implementation is needed. Direct collaborative efforts between the DAMA and beamline controls subgroups have yielded rapid and rewarding results.

Comments:

Issues are currently handled in an on-fire basis, and *clear prioritization of needs should be addressed on a management level*. The POC system is new, and beamline staff have generally not adjusted to the additional layer of management (continue to contact the legacy "beamline controls engineer" when possible). There is a need to move from a "construction" to a more "operations" based mentality. Getting controls engineers out on the floor is beneficial for interaction with beamline staff, investment in the projects and also training. There is a sense of trying to just make things work, when all should be targeting creating controls for a world-class facility.

Recommendations:

Adoption of more simple motor control solutions than Delta Tau (DT) for appropriate systems (or improved automation of motor setup and tuning if possible) may help reduce the burden on controls staff. Alternatively, contractors or vendor contracts could be used to supplement staff efforts. Consider bringing in a DT engineer for a few months to address issues and train staff *in situ*. Overall, additional talent is needed, with a preference for junior staff with strong interest and a willingness to learn.

5. Is the level of "uniformness" and user friendliness adequate?

Findings:

The level of "uniformness" and user friendliness is not adequate. This is not uncommon for a facility at this stage of its lifecycle. It is however, necessary to develop and apply standards and guidelines, and closely manage those standards.

- It is not clear to beamline scientists, controls or the DAMA group which product is used where and why.
- CS Studio UI's aren't consistent across beamlines. UI schema are not used for CS Studio.
- At least one bespoke GUI has been developed for beamlines.
- There are departures from the naming convention for EPICS PVs on beamlines.
- Many EPICS PV do not have the 'units' field populated.
- Configuration of motion controls is excessively complex and time consuming.

Comments:

There is room for improvement of the level of consistency of interfaces across the hardware and software stacks.

Some standards are in place, however, it appears these standards are incomplete and there is evidence that existing standards are not always followed. Inconsistency at the bottom of the stack will propagate through to the top of the stack, resulting in additional effort to develop and maintain system, and open up the risk of errors in data. Total cost of ownership and reliability will be improved by efforts to develop, maintain and enforce standards.

It is not uncommon for MX end stations to depart from the host facility GUI standard and adopt a scientific community based GUI e.g. MXcube. Developments of bespoke GUIs are of value if there is significant innovation over existing products, otherwise, an existing product should be adopted.

It would be useful to provide a roadmap for consistent GUI standards for all beamlines. Is it going to be CS Studio, or a GUI over BlueSky, or both? It must be clearly articulated what the use cases are for these products.

GUI design would benefit from a style guide and QC processes to ensure consistency across beamlines.

Consider providing quality control processes for EPICS for naming conventions and units field.

Ensure all beamline / end station PVs are available via EPICS channel finder.

In the longer term the facility may wish to review the use case for CS Studio for the beamlines. This would involve working with beamlines to determine if the product is fit for purpose. If CS Studio continues to be used, review the addition of a python interface to CS Studio. In the committees view there are higher priority concerns to address in the short term.

Recommendation:

Promote robust development processes that bring about compliance to development standards and ensure quality of the software and solutions delivered.

6. Is the interaction between the internal groups, e.g. DAMA group adequate?

Findings:

The committee notes the organization structure that exists between the groups within controls and the rest of NSLS-II.

Comments:

Interaction between the groups within Controls occurs, but there is scope for improvement. The groups understand the relationships with each other and their respective responsibilities. However, responsibilities are partitioned horizontally i.e. Motor controller, EPICS, BlueSky, while functionality is vertical partitioned so establishing standards and communicating effectively across boundaries is needed. It is also important to share knowledge of each of the layers across groups i.e. particularly between Beamline Controls and DAMA, to effectively debug the full software stack from the science users down to the hardware. So there is scope for improved communication such that all groups understand overall project priorities and improve cross group working in true team fashion.

Interaction in terms of Detector support again appears to be well understood. In terms of other groups, there was insufficient information to make an informed judgement.

Recommendation:

Look for opportunities to improve group interactions. These could include:

- Controls-only all-hands meetings to discuss goals, strategy, issues, plans etc.
- Talks by engineers, open to other technical groups and beamlines staff. Topics might be recent work, emergent problems, cyber security etc.

Consider forming muti-disciplinary teams for appropriate projects. This brings an element of vertical integration to an otherwise horizontal organization structure. Given the staff levels available, this would likely be part time assignments. Assigning temporary team leads would give staff development opportunities.

7. Are there opportunities for improved efficiencies that we should consider?

Comments:

The committee believes there are opportunities for improvement.

Much work has been done in order to work-around NFS server problems by distributing to local machines. From what the committee heard of NFS server performance there are clearly major issues with it. Distribution of files from a centralized NFS file server is something that is very common and used in many facilities world-wide. There is nothing inherently wrong in this approach. It seems to the committee that it would be more efficient to resolve the problems with the NFS server rather than create work-arounds. Vendor support, SMEs from ITD or consultants are resources that could be utilized.

Work is being done on developing the alarm handler and other high level tools. These can and will be powerful tools in helping to run reliable, efficient beamlines. However, we did not hear from beamline personnel that these were important issues for them at this point in time.

It is clear that staff take a pride in the facility and their work. Given the limited resources all facilities are faced with, it is important to recognize when solutions are "good enough" and fit for purpose. There can be a temptation to deliver "gold plated" solutions. We heard examples of senior engineers performing simple tasks.

Having a standard motion control solution is good. The solution used at NSLS-II is complex in order to accommodate complex use cases. We heard that motors can take a long time to tune and that beamlines scientists cannot set up their own motors, even for simple mechanisms.

Recommendations

Management should ensure effort is directed at priorities that are aligned with the strategic direction of the facility. It is important that the strategy is well elucidated to staff. It will help people see how their efforts fit into the bigger picture and to understand the reasoning for particular decisions.

Resolve the problems with the NFS server rather than create work-arounds.

We recommend that the computing team work with beamline personnel to determine common pain points for beamlines in a systematic way. These can then be addressed as a priority. If possible, address these issues in a way that takes steps towards the end goal.

For example, a fully featured data management and curation system for users may be an end goal, but as a first step it could be possible to deploy an SFTP server for use by all beamlines as an option for users to transfer data.

Investigate opportunities for level-1 support (simple tasks) to be performed by junior staff and for ways to enable beamlines to perform self-help. This would free senior staff for more complex, involved tasks.

Investigate the benefits of having a standard "low end" motion control solution for simple mechanisms. Advantages would be that it would be quicker to configure and would allow beamline personnel to set up their own mechanisms. There may be such solutions already in use in the community that could be adopted.

8. Overall Assessment

Findings:

The NSLS-II project has completed the initial construction and the machine is operating with a world-class emittance. The photon beamlines program has delivered around 20 of the 27 beamlines in various states of commissioning. NSLS-II is well placed to be a world leading light source.

In recent months, there has been significant loss of Controls Group staff. From the discussions with staff, morale is very low and there is feeling of being asked to do the impossible.

Comments:

The establishment of routine operation of NSLS-II with world class photon beam parameters is a major achievement. The beamline buildout has been very aggressive compared to other projects and again is a major achievement. From a tour of the beamlines, they are well engineered and appear well placed to enter into the user program.

NSLS-II appears to be a caught between limited available funding pressures and the opportunity to be a world leading light source. Comments from the Science Advisory Committee that funding for Controls Computing is comparable to other US light sources, while possibly factually correct, misses the point that those facilities came online 20 plus years ago. Since then source properties and science opportunities have evolved and the other facilities are established facilities and so have reached steady state resource needs. NSLS-II on the other hand is a developing facility and with a developing science program, that will make greater use of new techniques based on imaging and reconstruction techniques like tomography, ptychography, CDI, and multi-modal experiments. So the needs of NSLS-II will be much more data and computationally demanding. As such, NSLS-II needs to adopt a significantly different resource model than current, if it is going to achieve its stated objectives. Looking at the world scene, it is evident from developments in Europe that facilities there are already aware of these challenges and are evolving their resource model accordingly.

Staff with skills in software and computing are key to achieving the inherent capabilities of the source properties of NSLS-II. However, there is now an incredible demand and hence opportunities for those same skills elsewhere and so this is an ongoing problem of recruiting and retaining these skills for all such facilities around the world. NSLS-II has to recognize that this loss of such staff, or

ongoing staff turnover of staff, will directly impact what it could ultimately achieve if the issues are not addressed. To address them, NSLS-II should look to create a working environment, career opportunities and reward which are comparable to other employment opportunities in the software/controls/computing industry both locally and nationally. The committee heard a consistent message from staff that they believed more opportunities for training and to attend conferences would benefit the facility and enhance their career prospects.

Recommendations:

Software and computing are an enabling technology for science facilities such as NSLS-II. Efficiencies come from not duplicating functionality across the organization while ensuring good engagement of staff through domain specific knowledge. NSLS-II needs to challenge all assumptions in its staff model to ensure across the facility that staff number are optimal. With such evidence NSLS-II should consider entering into discussion with funders as to the scientific needs and benefits for additional staff. In considering future beamline programs these should be realistically resourced for initial construction and ongoing operations.

Having established a realistic resource model, NSLS-II management should look at structures and create a working environment, career opportunities and reward which are comparable to other employment opportunities in the software/controls/computing industry both locally and nationally. Management should ensure there are reasonable opportunities for professional development of staff. This would include training and conference attendance as funding allows.

Senior NSLS-II management should set clearly defined objectives and priorities for the Controls Group, which are aligned to overall project goals. These should flow down from the strategic goals of the facility. Controls management should accordingly ensure staff are given clearly defined priorities and objectives for tactical day-to-day operations.

Appendix A: Beamlines Controls Review Charge

The operation and management of the Beamlines group review, including the motion and EPS group.

1. Are Beamlines controls appropriately staffed and managed?
   Consider – Levels of staffing, areas covered, responsibilities, other group responsibilities

2. Are the Point of contact and issues tracking systems adequate?
   Consider other tracking options, over/under delivery, transition to ops

3. Does it service the technical needs of the Beamlines Scientists?
   Consider fit for purpose, features vs bugs, growth,

4. Is the level of "uniformness" and user friendliness adequate?
   Consider User interface, amount of standardization, duplication of effort

5. Is the interaction between the internal groups, e.g. DAMA group adequate?
   Consider also over all org, mechanical, elect groups, Detectors etc.

6. Are there opportunities for improved efficiencies that we should consider?
   Supporting Documentation: The results of earlier reviews will be available.

Appendix B: Review Committee

Jen Bohon – Case Western Reserve University (NSLS-II UEC/SAC)

Kevin Brown – Relativistic Heavy Ion Collider, Brookhaven National Laboratory

Daniel Flath – Linac Coherent Light Source, SLAC National Accelerator Laboratory

Nick Hauser – Australian Nuclear Science and Technology Organisation

Mark Heron – Diamond Light Source

John Maclean (Chair) – Advanced Photon source, Argonne National Laboratory