OPEN XAL STATUS REPORT 2016*

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Abstract

Formed in 2010, the Open XAL accelerator physics software platform was developed through an international collaboration among several facilities to establish it as a standard for accelerator physics software. While active development continues, the project has now matured. This paper presents the current status of the project, a roadmap for continued development and an overview of the project status at each participating facility.

INTRODUCTION

Open XAL [1, 2] is being positioned as the standard open source accelerator physics software platform. It was born out of the XAL [3] accelerator physics platform from the Spallation Neutron Source (SNS) at Oak Ridge National Lab (ORNL) with the goals of modernizing the source code, normalizing the build system and supporting collaboration. Today, the active collaboration consists of the China Spallation Neutron Source (CSNS) in Dongguan, China, European Spallation Source ERIC (ESS) in Lund, Sweden, Facility for Rare Ion Beams (FRIB) at Michigan State University in Lansing, MI, Spiral2 program at the Grand Accélérateur National d'Ions Lourds (GANIL) in Caen, France, SNS in Oak Ridge, TN and TRIUMF in Vancouver, Canada.

COLLABORATION

The constituency of the collaboration has remained stable. Most notably, the project has been migrated from Source Forge to GitHub as the latter's project management and workflow are better aligned with our project needs. The project is now located on GitHub at https://github.com/openxal with the home page at https://openxal.github.io following the GitHub convention. Also with this change, new commits will automatically be evaluated with continuous integration using Travis [4].

SITE SPECIFIC STATUSES

Significant work on this project continues at the various sites with highlights as follows.

CSNS

The DTL-1 commissioning was finished at the beginning of this year. The old XAL is still used for commissioning and it has worked well. In addition to the old applications, new XAL applications like Magnet Manager and Model Manager were developed and used during commissioning.

It is planned to migrate to Open XAL after completion of the DTL-1 commissioning and to use the new Open XAL for the next commissioning phase which begins later this year.

A Machine Simulator application (see Fig. 1) has been developed and contributed to the Open XAL repository. This application replaces the old XAL's MPX application and provides many enhancements over it. Significantly, the user interface has been redesigned to be easier to use with quicker navigation and element filtering, and the application also retains and displays the results for all of the user's runs and supports automated parameter scans.

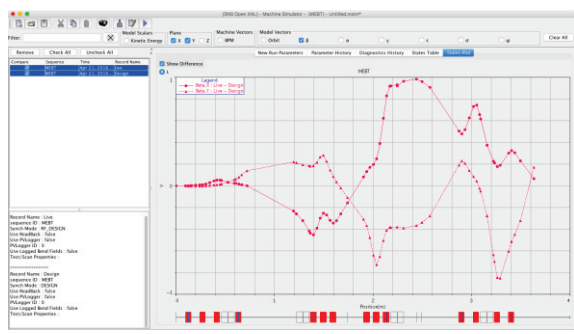

Figure 1: Machine simulator application

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ESS

As of 2015 the Open XAL model has been modified to handle field maps for the cavities. To verify the model, the SNS lattice was updated with field maps data and new benchmarks have been made with the measurements from SNS [5, 6]. The model was further extended with a general handling of misalignments and rotations of beamline elements.

As the commissioning of the ESS accelerator approaches, the less general applications, currently used only at SNS, have been reviewed. The Model Manager application [7] (see Fig. 2) has been extended to ease configuration and running of the model and comparison of the results. Besides a lot of minor work on applications, low level implementation of virtual accelerator application has been improved and the ESS RBAC [8] service was integrated with Open XAL.

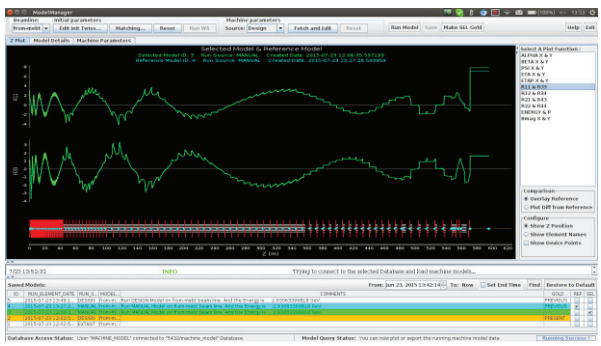

Figure 2: ESS model manager application

Further work is expected on the non-linear extensions to the model, application development and scripting environment for the commissioning and integration of ESS devices and services. See the site.ess.master branch for the ESS specific code.

FRIB

Prototype physics applications have been developed for beam commissioning of the FRIB linac with Open XAL, and all the beam tuning exercises are conducted using the online model. Open XAL is applied for linac cavity phase and amplitude tuning with beam time-of-flight measurements, longitudinal beam matching with bunch length measurements, and transverse beam matching with beam size measurements. We also study beam based alignment orbit correction with the online model which is important for high power operation when a precise beam orbit is needed to the FRIB linac. It satisfied all the requirements of beam commissioning and low power operation of the linac. However, future works are still necessary for some special features of the FRIB linac, such as, online model of multi charge state beams and correction of second order achromatic beam transport systems.

GANIL (SPIRAL2 Project)

The commissioning phase of the new Spiral2 facility started in fall 2014. Open XAL has been used as a toolbox and framework for the machine from the beginning including the sources plus low and medium energy beam lines. Applications developed with Open XAL, adapted to the variety of species and ions to be later accelerated in the Spiral2 LINAC are used to analyze the ions, define admittance, visualize and measure the beam transverse profiles, manage the theoretical and tuned parameters in link with a relational database. Open XAL optimization algorithms have been used in a multipurpose application to tune the beam (matching, alignment, transmission). The longitudinal emittance measurement (see Fig. 3) downstream of the RFQ has been done using a customized application. Future work is still necessary for tuning the cavities.

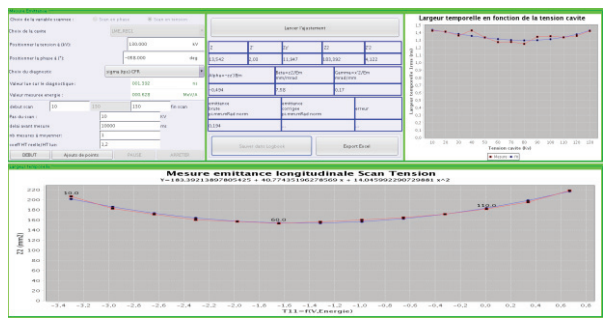

Figure 3: Spiral2 longitudinal emittance measurement

SNS

SNS has officially migrated to and embraced Open XAL, and the old XAL is no longer supported and its build products have been removed from the controls network. On the controls network, two main Open XAL branches are supported plus a test branch. One branch tracks the collaboration's changes and provides the latest features, scripts and applications which most benefits the accelerator physicists running machine studies. This software has passed all unit tests and has undergone some additional verification. The second branch is a production branch which has been certified as production ready for operations staff and has undergone formal verification in addition to passing all unit tests. The production code is only modified to patch bugs or add features at the request of operations staff, and must be formally tested prior to deployment. The test branch may optionally be employed for testing and certifying the production branch prior to deployment without disturbing the current production version.

Please see the site.sns.master branch for the active development SNS specific code.

DEVELOPMENT HIGHLIGHTS

A few of the many Open XAL developments in the past year are briefly discussed here. As usual, bug fixing is an ongoing activity as bugs are discovered.

The Cosylab/ESS team introduced a new high performance channel server in the JCA plugin and added support for it to the ChannelFactory. The virtual accelerator was modified to use the new channel server. In support of this change, each AcceleratorNode subclass now has a constructor that takes the ChannelFactory from which it should create its channels.

The online model and associated scenario generator have undergone major changes. The scenario generator has been refactored to support hierarchies. Each RF Gap can now store its transit time factor function potentially allowing for improved accuracy over a greater range of input energy. Probes and trajectories can now be saved to and restored from a data adaptor thus allowing them to be recorded in a document's file.

The solver performance has been analyzed and several issues were identified and addressed. Most importantly, the interactions among the various optimization algorithms have been modified to improve the overall performance. Furthermore, the code has been simplified.

Some changes have been made to Open XAL (mostly in the Launcher application) to support multiple concurrent deployment locations. This has allowed us to maintain a production branch for operations, a development branch for physics machine studies and a test branch for certifying a candidate for production.

FUTURE WORK

While Open XAL is production ready for SNS it still must grow to have new capabilities to match the needs of current and future accelerator physics work while advancing the platform as new technologies emerge. Work is also needed to support the varied needs of all the collaboration facilities. It is a major goal of and challenge for this project to normalize a common API to support the variety of accelerators thus establishing Open XAL as the standard accelerator physics software platform.

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