Plans for Performance and Model Improvements in the LISE^{++} Software

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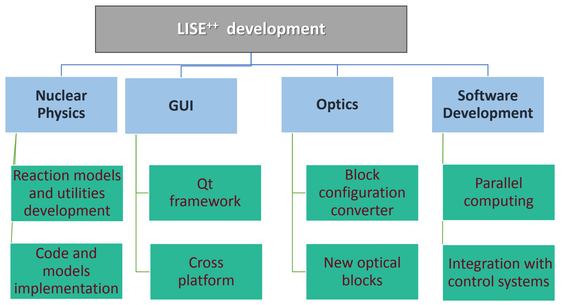
Introduction

LISE^{++} is the standard software used at in-flight separator facilities for predicting beam intensity and purity [1]. The code simulates nuclear physics experiments where fragments are produced then selected with a spectrometer. The use of LISE^{++} in most facilities is to predict and identify the composition of Radioactive Nuclear Beams. Intensity and purity of a desired beam can be predicted, along with the separator magnet settings. The LISE^{++} package [2] allows simulation of isotope production, separation, ion optical transport through magnetic and electric systems, and ion interactions in matter. The suite includes utilities for simulation of experiments. A set of modifications are planned to improve the functionality of the code.

LISE^{++} Development Plans

The LISE^{++} software package will be transported to a modern graphics framework with new compilers to aid in the performance and sustainability of the code. To accommodate user diversity, LISE++ will be adapted for cross-platform compatibility. The computational demands associated with more complicated devices at new large scale facilities should be addressed. In order to perform the necessary calculations in an acceptable time, code optimization and parallel methods will be applied. New features such as optimization, for example, of ion optics, improvements in reaction models, and new event generator choices are planned. Finally creation of a LISE^{++} interface with control systems is envisioned.



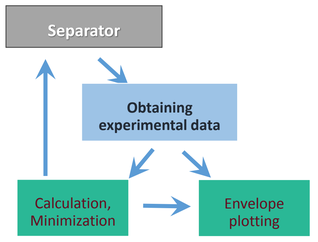
Development scheme for the LISE^{++} update. The plan is to first do a graphics framework transportation, verify the new code, then implement improvements and new features.

Software Development

Qt framework : The LISE^{++} program will be transported to a modern graphics framework for compatibility with future operating systems. Benefits include provisions for 64-bit operation, cross-platform compatibility, and the ability to take advantage of computational advances. Qt was chosen as the graphics framework based on its cross-platform capabilities, large feature set, and widespread use in cross-platform C++ applications.

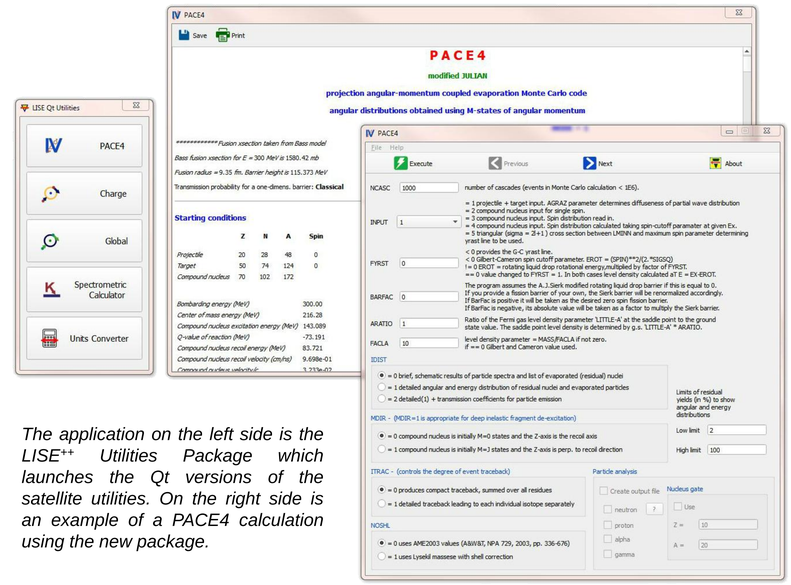
Parallel computing : To take advantage of modern computing architecture, parallel computing methods are essential in achieving faster computation. Once transportation of LISE^{++} to the Qt graphics framework is complete, we will be able to implement parallel computing on personal computers using OpenMP. In the future, large-scale calculations using supercomputers or many-core machines using MPI is also planned.

Integration with control systems : In order to directly assist the tuning of a separator, the LISE^{++} program will be integrated with control systems. This will be tested at labs such as NSCL and GSI.



Current Progress

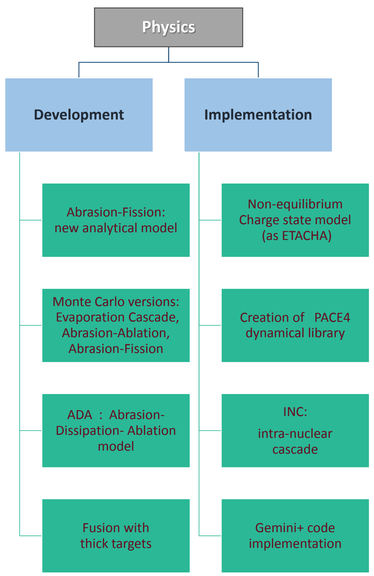
On March 4, 2015, the LISE^{++} Utilities Package was released. This is a cross platform package of the satellite utilities distributed with LISE^{++} to Qt. The package consists of five stand-alone programs useful for experiment design. They are PACE4, Charge, Global, the Kantele spectrometric calculator, and a units converter. Versions are available for Windows, Mac, and Linux. New documentation for the utilities is available on the website [4]. An example of the utilities package in action is given in the figure below. Work is now underway to transport the rest of the LISE^{++} software to the Qt graphics framework.



The application on the left side is the LISE^{++} Utilities Package which launches the Qt versions of the satellite utilities. On the right side is an example of a PACE4 calculation using the new package.

Nuclear Physics

Creation of in-house reactions models and implementation of modern powerful algorithms in the code remains an important priority for LISE^{++} development. Recent experiments at RIKEN and GSI showed that the LISE^{++} 3-Excitation-Energy-Regions model does not reproduce yields of high-Z neutron rich isotopes well and indicates the necessity of improving in-flight fission yield calculations. A new analytical AF model will be developed soon by Monte Carlo benchmarking. A "Dissipation" step will be inserted in the Abrasion-Ablation model to improve qualitative agreement with measured projectile fragmentation cross sections at lower energies and with heavy targets.

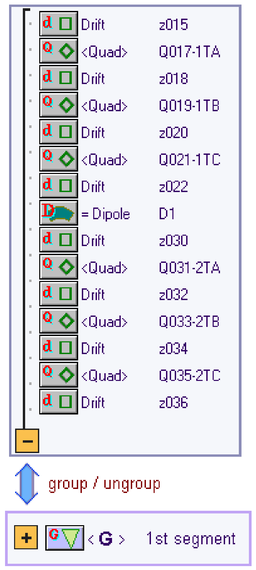


Optics

Block configuration converter : This new tool will be built around a new type of block, labeled "G"(Group), which allows the grouping (and ungrouping) of "E"(Element) blocks. The tool can be applied to create sector configurations for fast analytical calculations. E-block properties of a G-block will be used in MC mode for high order optic transmission calculations, and "S"(Sector)-block properties in the Distribution mode for experiment planning.

Minimization procedures : 1st order minimization of optics by varying magnetic fields (and/or electric voltages) of E-blocks will be used in the Distribution mode, and high-order minimization with a Monte Carlo method based on the "levmar" package will be implemented[3].

LISE^{++} blocks : Gas-filled optical blocks will be developed. "E"- versions will be created for some already existing "S" blocks, and multipole properties of the "drift" block will be moved to a special block.



References and Links

[1] LISE^{++} : Radioactive beam production with in-flight separators O.B.Tarasov, D.Bazin, NIM B 266 (2008) 4657-4664

[2] LISE^{++} website : http://lise.nscl.msu.edu

[3] levmar: Levenberg-Marquardt nonlinear least squares algorithms in C/C++. M.I.A. Lourakis July 2004. http://users.ics.forth.gr/~lourakis/levmar/

[4] LISE^{++} Utilities Package: http://lise.nscl.msu.edu/porting

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