Updating the LISE^{++} Software and Future Upgrade Plans

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Introduction

Production of new isotopes is at the intensity frontier of nuclear physics. The associated science address the stability, origin, and content of atomic nuclei. Scientific programs range from tests of the Standard Model to exploration of the origin and evolution of the chemical elements in the universe. Leading facilities in this effort include RIKEN in Japan, TRIUMF in Canada, GSI in Germany, GANIL in France, JINR in Russia, and ISOLDE at CERN. New large scale facilities under development include FAIR in Europe, FRIB in the United States, and others in countries including China, France, Korea, and Italy. Many of these facilities produce rare isotope beams by in-flight production and separation by interaction of a projectile beam on a target, followed by a spectrometer for in-flight fragment selection. Simulation of isotope production at these facilities is crucial for experimentalists in this field.

What is the LISE^{++} Software Suite?

LISE^{++} is the predominant isotope production and simulation software used at many of the facilities mentioned above. The software has two primary uses: experiment planning and spectrometer design.

The former uses the LISE^{++} software to simulate the production transmission and yields of desired projectile fragments through a spectrometer [1]. LISE^{++} provides models for reaction mechanisms for isotope production : projectile fragmentation, fusion-residual, fusion-fission, coulomb fission, and abrasion-fission. For spectrometer design, construction of a spectrometer is implemented through the use of material and optical “blocks”. These “blocks” can consist of detector and target materials, dipole magnets, and other materials commonly used in these experiments..

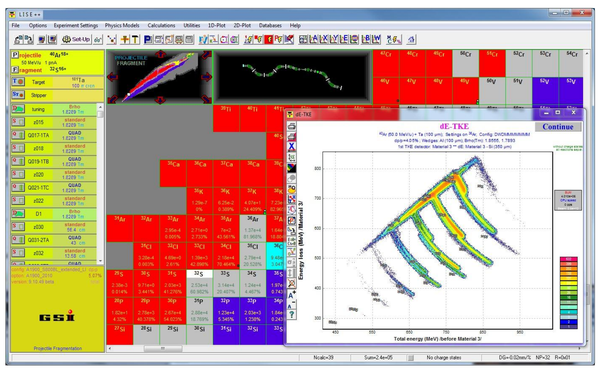

Fig. 1: The LISE^{++} main GUI with a ΔE vs Total Kinetic Energy particle identification simulation plot overlaid.

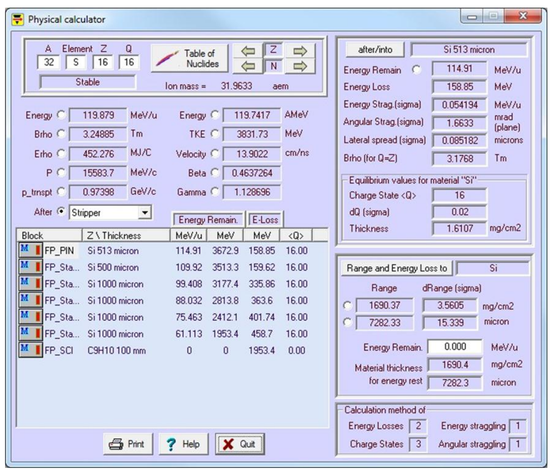

Fig. 2: The physical calculator is a widely used utility in the LISE^{++} framework. It calculates the energy loss through an unlimited number of material “blocks”.

Updates and Future Plans

To ensure longevity of the LISE^{++} program for future operating systems, the LISE++ program will be transported to a modern graphics framework. Additional benefits include providing a 64-bit application, cross-platform compatibility, and the ability to take advantage of computational advances.

The calculations of beam transport and isotope production are becoming more computationally intense with the new large scale facilities. For example, the 90 m long FRIB separator will have around fifty magnetic elements and ten points of beam interactions with matter. In order to perform the calculations in acceptable time, numerical optimization and parallel methods will be applied.

Qt was chosen as the graphics framework for its feature set and widespread use in cross-platform C++ applications

Future plans include improved numerical optimization methods in areas such as ion optics and reaction models. Lastly, integration with control systems are planned.

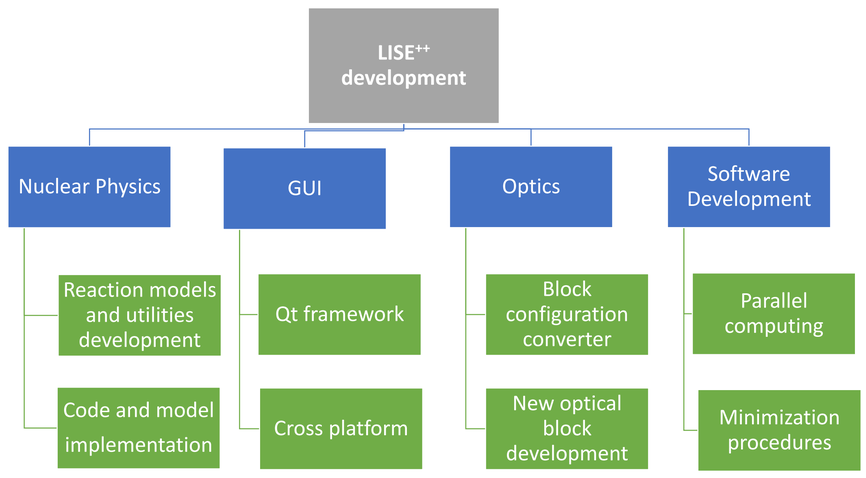

Fig. 4: Development scheme for the LISE^{++} update. The plan is to first do a graphics framework transportation, verify the new code, then implement improvements.

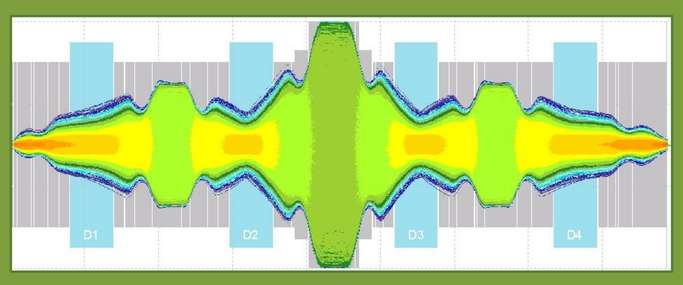

Fig. 3: Horizontal space envelope of the A1900 fragment separator at NSCL calculated with LISE^{++}. This represents the beam ray paths through the spectrometer.

Motivation for Update

The current version of LISE^{++} is available on the Windows operating system with 32 bit compilation. The program was developed within the Borland C++ framework. In order to update the software to meet demands of the new large scale facilities, the software will be converted to a new development environment. Since 1998, the code has grown immensely. It started on MS-DOS with 14 C++ files and grew to 606 files on MS Windows today. With over 350 thousand lines of code, this is a significant undertaking and the verification and validation of the conversion is a very important process.

Current Progress

The first release of the new LISE^{++} software suite was the LISE^{++} Utilities Package, released March 4, 2015. This is a cross platform transportation of the satellite utilities in LISE framework to Qt. The package consists of five stand-alone programs useful for experiment design.

Work is now underway to convert the entire LISE^{++} program to Qt with ISO C++ Standard.

Fig. 5: The application on the left side is the LISE^{++} Utilities Package which launches the Qt ISO C++ versions of the satellite utilities. On the right side is an example of a PACE4 calculation using the new package.

Download

LISE^{++} : http://lise.nscl.msu.edu/download/
LISE^{++} Qt Utilities: http://lise.nsl.msu.edu/porting

References

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

This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number: DE-NA0000979 through the Nuclear Science and Security Consortium and the US National Science Foundation under Grants No. PHY-06-06007, No. PHY-10-68217, and No. PHY-11-02511.
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The NSCL is funded in part by Michigan State University and the National Science Foundation.