

GAVA – A Graphical Pulse Sequence Simulation, Display and Storage Environment

Z. Aygula¹, B. J. Soher¹, K. Young², A. A. Maudsley¹

¹University of Miami, Miami, FL, United States, ²Stanford Linear Accelerator Center, Menlo Park, CA, United States

SYNOPSIS

Spectral simulation is an effective and efficient means for optimizing data acquisition sequences and for facilitating spectral analysis. GAMMA is a powerful C++ library, which can be used to describe and simulate NMR experiments. In this study we report the development of a graphical tool using IDL, GAMMA and MySQL, which can run predefined or user defined pulse sequence simulations, display results in a variety of forms and store the results for later use.

INTRODUCTION and METHODS

GAMMA [1] is an object-oriented library written in C++ that facilitates software development for simulation of NMR experiments. It provided the entities and operations common to NMR experiments as programming objects that extend the C++ language allowing matrices, operators, commutators, spin systems, and rf pulses to be simply described and applied in program procedures. GAMMA is a broad and flexible tool for NMR analysis; however, it does require knowledge of C++ programming and has only very general tools for display and storage of results. In this report we describe an integrated pulse sequence design, simulation and storage environment called GAVA.

RESULTS and DISCUSSION

GAVA is a graphical control and display program written in IDL (RSI, Inc. Boulder, CO) that interfaces the functionality of the GAMMA library with the powerful query and storage functions of the MySQL database. In Figure 1 is shown a basic flow diagram for the functionality of the GAVA environment. The GAVA GUI allows the user to edit prior information about pulse sequences or metabolites (e.g. chemical shifts and J-couplings), access previously stored simulations, run new simulations on one or more metabolites and display or store the results. Common uses for this tool have been: 1) Simulating multiple metabolites for a single TE and pulse sequence for use as basis functions in spectral analysis tools [2], and 2) Simulating one metabolite for multiple, progressive TE values to determine optimal pulse sequence settings for a given acquisition.

GAVA provides a number of predefined pulse sequences including, one-pulse, spin-echo, STEAM, and PRESS, whose parameters are all user definable. Selected sequences may be run to include the effects of spatial variations in the B₁ profile. Additional pulse sequences designed by knowledgeable users can be integrated into the environment. GAVA is capable of simulations that make use of both ideal RF pulses (defined in GAMMA) and user-defined real RF pulses. Additional entry fields allow simulations to be annotated before storage. The display widget allows for some or all of the metabolites to be displayed individually or in a stack plot. Spectral display parameters are all user definable and interactive. Regional integrals can be plotted for the multiple TE simulations to determine which TE gives the maximum signal for a given resonance group. All screen views and simulation results can be output to a variety of file formats. Figure 2 (a-b) displays the simulation window and spectral plot window, respectively.

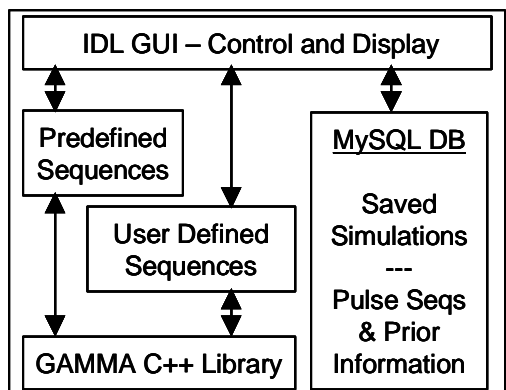


Fig.1 GAVA flow diagram.

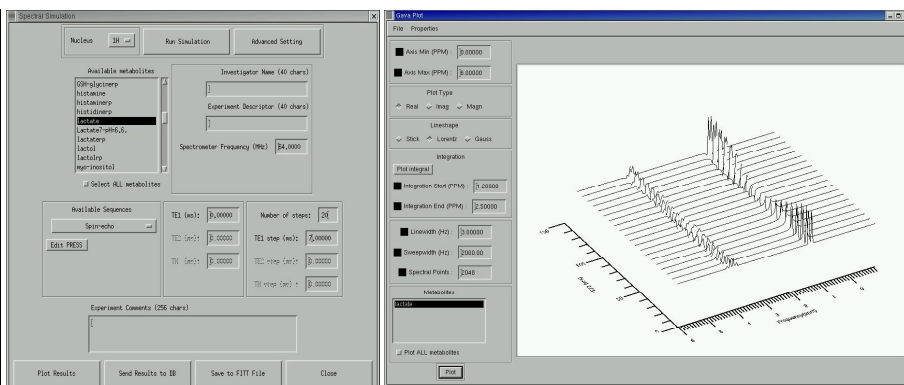


Fig.2 a) Main simulation window.

b) Display and integration widget.

REFERENCES and ACKNOWLEDGEMENTS

1) S.A. Smith et.al., J. Magn. Reson. Ser. A 106, 75-105, 1994. 2) B.J. Soher et.al. Magn Reson Med 40, 822-831, 1998. The authors would like to acknowledge the following NIH funding - R01EB00207