GEANT-4 GPU Port:

Design Document: System Architecture

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1 Introduction

1.1 Purpose

The purpose of GEANT4-GPU is to reduce the computation times of particle simulations using the GEANT4 simulation library.

1.2 Description

The project aims to improve the computation times of Geant4 particle simulations by running certain parallel operations on a GPU. GEANT4-GPU will be a fork of the existing Geant4 system with the additional option for users with compatible hardware to run operations on the GPU for improved performane. This functionality will be available on Mac, Linux and Windows operating systems running on computers with NVIDIA graphics cards (G8X series or later).

The design strategy for the project will be based on taking a specific, computationally heavy class from Geant4 and creating a class that fulfills the same interface but that runs on the GPU. This will be repeated for many classes until the project's deadline has been reached. The user will have the option of using the existing classes (running on the CPU) or the new ones (running on the GPU).

1.3 Scope

The scope of the project in terms of modules to port to the GPU will be limited to physics simulations run by the McMaster Engineering Physics department.

Revision History

All major edits to this document will be recorded in the table below.

Table 1: Revision History

Description of Changes	**Author**	**Date**
Set up sections and filled out Introduction section	Matthew	2015-12-15

2 Anticipated and unlikely changes

2.1 Likely Changes

2.2 Unlikely Changes

3 Module Hierarchy

4 Connection between requirements and design

5 Traceability matrices

5.1 Note About G4 variables

Geant4 uses its own basic types for standard C++ types (G4int, G4bool, G4double, etc). These types are currently just `typedefs` to the respective type as defined in the system libraries.

6 MIS of NeutronHPDataPoint

6.1 Interface Syntax

Routine Name	Input	Output	Exceptions
G4NeutronHPDataPoint			
G4NeutronHPDataPoint	G4double, G4double		
operator(REVISE THIS)	G4NeutronHPDataPoint		
GetEnergy		G4double	
GetXsection		G4double	
SetEnergy	G4double		
SetXsection	G4double		
GetX		G4double	
GetY		G4double	
SetX	G4double		
SetY	G4double		
SetData	G4double, G4double		

6.2 Exported Access Programs

6.3 Interface Semantics

6.3.1 State Variables

- energy : G4Double

- xSec : G4Double

6.3.2 Environment Variables

There are no environment variables for this Module.

6.3.3 Assumption

6.3.4 Access Program Semantics

7 MIS of NeutronHPVector

7.1 Interface Syntax

Routine Name	Input	Output	Exceptions
G4NeutronHPVector			
G4NeutronHPVector	G4int		
SetVerbose	G4int		
Times	G4double		
SetPoint	G4int, G4NeutronHPDataPoint		
SetData	G4int, G4double,G4double		
SetX	G4int, G4double		
SetEnergy	G4int, G4double		
SetY	G4int, G4double		
SetXsec	G4int, G4double		
GetEnergy	G4int	G4double	
GetXsec	G4int	G4double	
GetXsec	G4double	G4double	
GetXsec	G4double,G4int	G4double	
GetX	G4int	G4double	
GetY	G4double	G4double	
GetY	G4int	G4double	
GetVectorLength		G4int	
GetPoint	G4int	const G4NeutronHPDataPoint &	
Hash			
ReHash			
InitInterpolation	istream		
Init	istream,G4int, G4double, G4double		
Init	istream, G4double,G4double		
ThinOut	G4double		
SetLabel	G4double		
GetLabel		G4double	
CleanUp			

Routine Name	Input	Output	Exceptions
Sample		G4double	
Debug		G4double *	
Merge	G4NeutronHPVector *, G4NeutronHPVector *		
Merge	G4InterpolationScheme, G4double, G4NeutronHPVector *, G4NeutronHPVector *		
SampleLin		G4double	
IntegrateAndNormalise			
Integrate			
GetIntegral		G4double	
SetInterpolation-Manager	const G4InterpolationManager &		
SetInterpolation-Manager	G4InterpolationManager &		
G4Interpolation-Manager		const G4Interpolation-Manager &	
SetScheme	G4int,const G4InterpolationScheme &		
GetScheme	G4int	G4InterpolationScheme	
GetMeanX		G4double	
GetBlocked		vector<G4double>	
GetBuffered		vector<G4double>	
Get15percentBorder		G4double	
Get50percentBorder		G4double	
Check	G4int		G4HadronicException
IsBlocked	G4double	G4bool	

7.2 Exported Access Programs

7.3 Interface Semantics

7.3.1 State Variables

- G4NeutronHPInterPolator : theLine
- totalIntegral : G4double
- G4NeutronHPDataPoint * : theData
- G4InterpolationManager : theManager
- G4double * : theIntegral
- G4int : nEntries
- G4int : nPoints
- G4double : label
- G4NeutronInterpolator : theInt
- G4int : Verbose
- G4int : isFreed
- G4NeutronHPHash : theHash
- G4double : maxValue
- vector<G4double>: theBlocked
- vector<G4double>: theBuffered
- G4double : the15percentBorderCash
- G4double : the50percentBorderCash

7.3.2 Environment Variables

There are no environment variables for this Module.

7.3.3 Assumption

7.3.4 Access Program Semantics

8 MIS of CMake Files

8.1 Interface Syntax

Routine Name	Input	Output	Exceptions
cmake_minimum_required	[VERSION],[FATAL_ ERROR]		[FATAL_ ERROR]
option	<option_variable>, string, [initial value]		
find_package	<package>,[version],[EXACT], [QUIET],[MODULE],[REQUIRED], [[COMPONENTS[components...]], [OPTIONAL_COMPONENTS components...], [NO_POLICY_SCOPE]		[FATAL_ERROR]
add_subdirectory	source_dir,[binary_dir], [EXCLUDE_FROM_ALL]		
include_directories	[AFTER |BEFORE],[SYSTEM], dir1, [dir2 ...]		
LIST	APPEND,<list>, [<element >...]		
project	<PROJECT-NAME >		
include	<file|module>[OPTIONAL], [RESULT_VARIABLE <VAR>,[NO_POLICY_SCOPE]		[NOTFOUND]
file	file(GLOB,<variable >[LIST_DIRECTORIES true|false],[RELATIVE<path>] [<globbing-expressions>...])		
add_executable	<name>,source1, [source2 ...]		

Routine Name	Input	Output	Exceptions
target_link_libraries	<target>... <item>... ...		[FATAL_ERROR]
add_definitions	-DFOO -DBAR ...		
message	STATUS string		[SEND_ERROR],[FATAL_ERRO-R],[DEPRECATION]
set	<variable><value>... [PARENT_SCOPE]		
configure_file	<input><output>, [COPYONLY]		
foreach	loop_var arg1 arg2 ... COMMAND1 (ARGS ...)		
install	TARGETS targets..., [DESTINATION <dir>]		

8.2 Exported Access Programs

8.3 Interface Semantics

8.3.1 State Variables

- useCuda : Bool

8.3.2 Environment Variables

- NeutronHPVectorGPU.cu : cuda file with GPU code

8.3.3 Assumption

8.3.4 Access Program Semantics