GENIE v3
Status report and LArSoft requirements

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Outline

- Features of Genie v3

- Consequences for any software linking against Genie

- Specific requests from LArSoft

GENIE Version 2.12.10

- CCQE models
    - Llewellyn Smith
    - Nieves, Amaro and Valverde

- MEC models
    - Empirical
    - Nieves Simo Vacas

- Nuclear Models
    - Relativistic Fermi Gas
    - Local Fermi Gas
    - Effective Spectral Functions

- Single Kaon
- Λ production

- RES
    - Rein-Sehgal
    - Berger-Sehgal
    - Kuzmin-Lyubushkin-Naumov

- COH
    - Rein-Sehgal
    - Berger-Sehgal
    - Alvarez Ruso

- FSI - Intranuke
    - Full Intra-Nuclear cascade
    - Schematic based on Hadron-nucleus data

- Only one Comprehensive Model Configuration (CMC)

- Default tune has not changed

Global model configurations - Main v3 feature

UNIVERSAL NEUTRINO GENERATOR
& GLOBAL FIT

graphics by `grafiche.testi@gmail.com`

- "Comprehensive Model Configurations"
  - Self-consistent collections of primary process models
  - Help cooperation between collaborations
    - Unified model identifications
    - Allow comparisons of physics results
  - Single command-line flag
    - `--tune G16_02a`
  - Complete characterization against public data
  - Willing to host configuration provided by experiments
- System flexible enough to allow tuned configurations with respect to datasets
  - `--tune G16_02a_01_003`

Comprehensive Model Configurations

Dedicated web page – `tunes.genie-mc.org/`

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Genie Global Tunes

This section contains the description of Genie's Global configurations and of their corresponding tunings against public data.

Naming convention

A uniform naming convention is required for all Comprehensive Model configuraion (CMC) and all its derived tunes (Comphensive model tunes, in short CMT) are identified by a single label. Although an impossibly large of information needs to be encoded in the names, they should remain reasonably short. Not only a CMC name will be a command-line argument for all GENIE applications, a CMC name will be the main vehicle for communicating full model configuration and tune information, often verbally.

It is rather clear that the names of the actual physics models, or the names of the datasets, can not be a part of a uniform and compact naming scheme. Such a naming scheme can only employ "keys" that can be used by users in order to look up the corresponding model configurations, parameter lists and datasets. It is expected that all this information will be maintained in the GENIE web page, and that the subset of that information pertaining to the currently supported CMTs will be included in the GENIE Physics and Users Manual.

A CMC is identified by a 7-character string in the form

Gdd_MMv

where

List of available configurations

CMC definitions and charachterization

The following list contains the details of the CMCs available in GENIE. Also, for each CMC, validation plots and Tunigs are available.

Configuration Brief description

G00_00a	Historical Genie default configuration.
G00_00b	Historical Genie default configuration, including empirical 2p2h.
G16_01a	Update of the historical default, including new interaction processes.
G16_01b	As G16_01a, with the inclusion of empirical 2p2h.
G16_02a	Comprehensive configuration anchored to the latest theory developments.

Global model configurations

Comprehensive Model Configurations

Details and configuration

G16_02a

This configuration is based on the latest theorical developments. Particular emphasis is on Nieve Model for CC 0π and CC 1π interactions.

The configuration of this CMC is a bit tricky as not only the models has to be changed. So, please pay attention at the notes in the comments sections or at the end of the table.

Configuration Table

ALGORITHM	MODEL	CONFIGURATION	COMMENTS
Initial Nucleus State	Local Fermi Gas	LocalFGM/Default	
CC QE	J. Nieves, J. E. Amaro and M. Valverde Phys. Rev. C 70 (2004)	NievesQELCCPXSec/Default	BBA05 elastic nucleon FF Dipole Axial Form Factor, M_A = 0.99 GeV/c²
CC 2p/2h	J. Nieves, I. Ruiz Simo, and M. J. Vicente Vacas PRC 83 (2011) Implementation by J. Schwehr, D. Cherdack and R. Gran arXiv:1601.02038	NievesSimoVacasMECPXSec2016/Default	turn SetDiNucleonCode to false*
CC RES	Ch. Berger, L. M. Sehgal Phys. Rev. D76 (2007)	BergerSehgalRESPXSec2014/Default	dipole axial FF, M_A = 1.12 GeV/c² 16 Resonances - No interference
CC DIS	E.A.Paschos and J.Y.Yu Phys. Rev. D65 (2002)	QPMDISPXSec/Default	Scaling factor = 1.032
CC COH Pion	Ch. Berger and L. M. Sehgal Phys. Rev. D 79 (2009)	BergerSehgalCOHPiPXSec2015/Default	
CC Diffractive Pion	D. Rein Nucl. Phys. B278 (1986) 61-77	ReinDFRPXSec/Default	
CC ΔS = 1 QE	A. Pais Annals Phys. 63 (1971) 361-392	PaisQELLambdaPXSec/Default	
CC ΔS = 1 Inelastic	M. Rafi Alam et at. Phys. Rev. D82 (2010) 033001	AlamSimoAtharVacasSKPXSec2014/Default	

Comprehensive Model Configurations - Why do we need this?

- Genie is not just a generator
  - We have data and a tuning analysis framework
    - ⇒ See my Fermilab neutrino seminar - September 2017
  - the Generator is just what "traditional" analysers are using

- v3 is the interface to a continuous modeling effort
  - Systematic usage of data to deploy configurations
  - Easy way to identify (and use) models developed by other experiments
    - Minerva
    - Liquid argon tune is a possible outcome of the SBN program
  - Help interaction between different experiments

- This approach is aligned with LArSoft commonality between experiments

Implementations

Toward Genie v3 - Techicalities

- LArSoft users are not using genie directly
    - ⇒ Differences needs to be propagated through the GENIE EventGenerator
    - Add a `tune` parameter in the fcl file
    - Set accordingly the RunOptions
        - CMC, Tune and Event Generator List
        - see https://genie.hepforge.org/trac/browser/generator/trunk/src/Framework/Utils/RunOpt.cxx

    - the global configurations will be in the `$GENIE/config` directory
        - Independent from the software
        - Models will be updated and mantained simply updating Genie
        - No model-specific updates expected in the API

    - ⇒ Here we could host specific configurations from experiments

- There are other changes which might affect the LArSoft interface
    - Stucture of the source code
    - Parameter input

Source code structure

- The code structure changed completely
  - Every code linking against genie will be affected

- There is a sed script that can update the header files
- trunk version
  - $GENIE/src/contrib/misc/replace_header.sh
  - $GENIE/src/contrib/misc/replace_header_files.sed

source: generator / trunk / src

Name ▲
⬑ ../
📁 Apps
📁 contrib
📁 Framework
📁 make
📁 Physics
📁 scripts
📁 Tools

Status

- TO DO: reorganization of the input parameters
    - Necessary to make things more coherent in the code
    - Development is happening in a private branch of the code
    - Mostly done ⇒ No changes expected in the API

- We are in a transition phase
    - Trunk is the best working candidate for v3
    - You can use it to start including and test Genie v3 in LArSoft

Requests from LArSoft

- Gianluca asked my to comment about two issues:

  - Experiments supporting the transition

  - Compatibility with old version

Experiments

- SBND is supporting the new version
  - ⇒ Most likely also the whole SBN program will support it

- v2 will be no longer mantained
  - No manpower to mantain a number of versions

  - ⇒ v3 will be the only genie version available anyway
 - I do expect other experiments to ask for it, eventually

Models

Backward compatibilty

- General approach:

  "Each old model will have a counterpart in v3 close enough to the corresponding v2 version"

- Most of the old models will be available exactly as they are now
  - Exceptions: FSI models
  - We have different versions of them periodically updated
  - The old ones - including the default - won't probably make it into v3
  ⇒ We are not really concerned as the running experiments are not using the old FSI models

- Example of things which won't be changed - click here

- Whatever old configuration people managed to set up it will be possible reacreated again
  - changes in the xml files to be compatible with the new parameters organization

Error report

- The interaction type definition is dumb
  ⇒ nusimdata/SimulationBase/MCNeutrino.h
  - it mixes different codes from different sotftware
  - One of those software package is not even in LArsoft

- Why is that? Can we use simply the Genie interaction type code?

- Nuance codes do not include MEC, so we should not use them at all!
  - Even Diffractive is missing, but I reckon is not a big deal in a LAr experiment
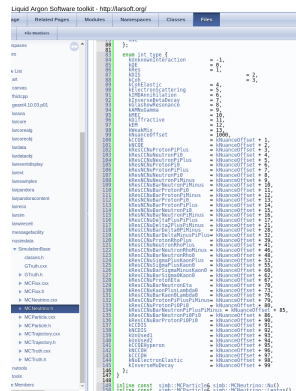
Conclusions

- It took a while but the release of GENIE v3 is getting close
    - present trunk can be considered an alpha version

- Things are interesting for LAr experiments
    - First large amount of data out of ν-Ar interactions
    - Huge potential in terms of modeling development
    - ⇒ Genie is a common ground for physics modeling

- Need to adapt LArSoft infrastructure
    - Not particularly challenging (personal opinion)
    - Comments or requests?

Backup slides

GENIE Collaboration

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- Core GENIE mission
  1. ... provide a state-of-the-art neutrino MC generator for the world experimental neutrino community
  2. ... simulate all processes for all neutrino species and nuclear targets, from MeV to PeV energy scales
  3. ... perform global fits to neutrino, charged-lepton and hadron scattering data and provide global neutrino interaction model tunes