LArSoft Accomplishments 2016

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1. Workshops/Special presentations:
    a. The June 22/23rd annual workshop http://indico.fnal.gov/event/larsoft-2016 had 50 registrants; several of them were LArSoft developers who have not attended any workshops previously. The post-workshop survey comments spanned from "was nice that did not start from novice and assumed some LArSoft/art knowledge" to "Would have been nice to have some novice/new developer sessions". The discussion and "tips and tools" sessions were popular. The two presentations on FHiCL are regarded as "must reads" now for new LArSoft users.
    b. Erica Snider presented a LArSoft introduction at the Young DUNE Workshop. The organizers reported that it received good reviews. http://vms.fnal.gov/asset/detail?recid=1943061
    c. Ruth Pordes recorded the presentation developed with Erica that she gave at ICHEP about LArSoft. It is available at: https://indico.cern.ch/event/432527/contributions/1071433/attachments/1319976/1981094/LArSoftICHEP_V05.pdf
    d. Spoke at the SBN joint analysis group meeting about onboarding a new detector into LArSoft. The presentation was aimed at providing information to ICARUS collaboration members who would port ICARUS reconstruction and simulation into LArSoft.
    e. art/LArSoft leads attended uboone LarLite/Larsoft integration workshop and came up with a list of action items to be formed into a plan. Before the integration of LArLite/LArSoft is acceptable, the issue of speed of initial load of the data products into pyroot had to be addressed. Involved root team to help. Reduced the number of headers that are exposed to the interpreter (i.e. pass to genreflex) but this also means that the content of those headers is no longer 'reachable/useable' from the python prompt.
    f. The LArSoft Notes article http://larsoft.org/cern-november-2016/ includes links to the presentations as well as the videos from a one-day tutorial in CERN.
2. Important Milestones
    a. Completed runs of callgrind@valgrind on readout simulation (DetSim) and reconstruction (two stages) with MicroBooNE configuration - readout simulation does not show any linear algebra call except the ones included in ROOT FFT interface (and they are not very relevant either.)
    b. PMA review documents posted
        i. Recommendations for code analysis process: CD-DocDB-5765
        ii. Report from the PMA code analysis: CD-DocDB-5766
    c. After discussion of linear algebra and vector libraries for LArSoft, narrowed the list of candidates and presented at Coordination Meeting, then at Offline Leads meeting where all agreed that this effort should be pursued further.

d. Received response from CERN and Fluka collaboration on plan and responsibilities for LArSoft /Fluka interface/integration. Will be discussing with the DUNE stakeholders and steering group.
e. Started discussion about ProtoDUNE Dual Phase geometry and whether LArSoft can support it. The answer appears to be yes; we need to design the right strategy.
f. PMA code authors have agreed to use new code for navigating the special cases of art::Assn's where the individual associations have known ordering. The new code is designed to simplify navigation in these cases, and may also provide performance gains.
g. Work is progressing on enabling the Kalman Filter as final fitter which addresses a major source of inefficiency in MicroBoone's CC-inclusive analysis.

3. The biweekly LArSoft Coordination meetings had a number of presentations that led to new capabilities within LArSoft. Slides and meeting notes are available at: https://indico.fnal.gov/categoryDisplay.py?categId=405

Some of note from the last six months are:

1. A new GDML generation framework 12/6/16
2. Parallelizing LArSoft using MPI and OMP 12/6/16
3. Changes in accessing art::Assns with metadata 12/6/16
4. Kalman fitter performance improvements 11/22/16
5. LArG4 re-factoring project report 11/22/16
6. Access to database for calorimetry 10/25/16
7. Adding optical truth information 10/11/16
8. Modularization of DetSim and DataPrep 9/27/16
9. Multi-threading LArSoft hit-finding 9/13/16
10. LArSoft / LArLite integration status 8/30/16
11. Sharing code between LArLite and LArSoft: flash matching 8/16/2016
12. Simulation and reconstruction of ProtoDUNE Dual Phase with LArSoft 8/2/16
13. Changes to MCParticle 7/19/16
14. CNN-based EM / Track ID 7/5/16

4. LArSoft Weekly Builds and software updates are available at https://cdcvs.fnal.gov/redmine/projects/larsoft/wiki/LArSoft_release_list

a. Completed the utility to simplify the creation of art::Ptr, currently called lar::PtrMaker. It may eventually become art::PtrMaker. Simplified the code by constructing a lar::PtrMaker object, either with data product and pointers in the same module or different ones, and use the index to create art::Ptr.
b. Changed LArSoft so it will work with Geant4 10.2 and above.
c. Able to build LArSoft on El Capitan. Caveats: SIP is disabled and openssl is installed with homebrew as keg only.
d. Plans to drop the Mavericks build of LArSoft and begins installing the El Capitan SIP disabled build on cvmfs as part of the release.
e. Making progress on adapting the LArSoft geometry to provide for the needs of dual-phase LAr TPCs.
f. The first version of the Kalman Filter track fitter was included in a LArSoft release.

g. Release specifics:

1. LArSeedService from larsim replaced by NuRandomService from nutools
2. Removing deprecated lar::utils namespace
3. Reorganization for nutools and calorimetry
4. Data member changed in sim::SimChannel
5. Repackaging of data products and adoption of ROOT 6
6. Moved test utility headers and libraries
7. SpaceCharge improvements require new call
8. SeedService from artextensions replaced by LArSeedService
9. Explicit override of LArG4 random seeds
10. ParticleList can't be copied any more
11. Photon Library returns plain data rather than vectors
12. photon detector reconstruction
13. Moving PitchInView() and ProjectedLength() out of track object
14. Repository structure refactoring
15. Core service refactoring

5. Documentation

a. Several LArSoft Notes released in the last year.

i. CERN LArSoft Tutorial Report – November 2016
ii. LArSoft/LArLite integration – September 2016
iii. LArSoft Workshop Report – August 2016
iv. Opening the box: event reconstruction using Pandora – June 2016
v. Concepts in LArSoft, CI, Algorithms – April 2016
vi. LArSoft forum, redmine – February 2016

b. Updated pages in larsoft.org.

c. Updated pages in redmine, including subpages:

i. https://cdcvs.fnal.gov/redmine/projects/larsoft/wiki/Quick_Links
ii. https://cdcvs.fnal.gov/redmine/projects/larsoft/wiki/Using_LArSoft
iii. https://cdcvs.fnal.gov/redmine/projects/larsoft/wiki/Developing_With_LArSoft
iv. https://cdcvs.fnal.gov/redmine/projects/larsoft/wiki/LArSoft_Internals

d. Are recording services as well as algorithms at http://larsoft.org/algorithms-list/

Algorithms that have been documented in larsoft.org

1. Blurred Cluster, Mike Wallbank, 2D cluster reconstruction technique which specialises in clustering hits from shower deposits by first applying a weighted Gaussian smearing to the hit map in order to more accurately distribute the charge and form more complete clusters.
2. Cluster Crawler, Bruce Baller, Reconstructs line-like 2D clusters, 2D vertices and 3D vertices.
3. EM Shower, Mike Wallbank, 2D cluster reconstruction technique which specialises in clustering hits from shower deposits by first applying a weighted Gaussian smearing to the hit map in order to more accurately distribute the charge and form more complete clusters.
4. Fuzzy Cluster, Benjamin Carls, A 2D clustering algorithm that attempts to ID shower and track like objects.

5. Image Pattern, Robert Sulej, Set of algorithms, modules and scripts performing pattern recognition in 2D images made of wire ADC waveforms. Algorithms are based on convolutional neural networks. There are tools for data preparation, running the network in the training and inference
6. Neutron Oscillation, Jeremy Hewes, Event generator module for GENIE neutron-antineutron oscillation
7. Nucleon Decay, Tingjun Yang, A module to simulate nucleon decays.
8. Projection Matching Algorithm, Robert Sulej, Dorota Stefan, Reconstructs structures of 3D tracks interconnected with vertices; the input is 2D clusters.
9. Remove Isolated Space Points, Gianluca Petrillo, Space point isolation detection (example)
10. Track 3D Kalman Hit, Herbert Greenlee, Reconstructs tracks applying Kalman filter on hits.

Services that have been documented on the website include:

1. Channel Status Service, Brandon Eberly, Service interface that provides access to a ChannelStatusProvider
2. Detector Pedestal Service, Brandon Eberly, Service Interface class that provides access to a DetPedestalProvider
3. Detector Properties Service, Jonathan Paley, Service that provides detector specific properties such as temperature, density, purity, lifetime, etc., all which may be run or time dependent and extracted from a database.
4. Geometry, Gianluca Petrillo, Description of detector geometry
5. LAr Seed Service, Gianluca Petrillo, Central management of random seeds

6. Project Management

a. Reviewed numerous Redmine issues about policy such as adopting a policy regarding parameter set validation, if and for statements, etc. Most of these required updating the coding guidelines to address these issues.: https://cdcvs.fnal.gov/redmine/projects/larsoft/wiki/The_rules_and_guidelines

b. Resolved dozens of old redmine issues.

c. Setting up Milestones with subtasks for LArSoft work.

- https://cdcvs.fnal.gov/redmine/issues/14454 - Refactoring LarG4
- https://cdcvs.fnal.gov/redmine/issues/14691 - January Notes article
- https://cdcvs.fnal.gov/redmine/issues/14703 - LArSoft 2017 Workshop planning
- https://cdcvs.fnal.gov/redmine/issues/14363 - Support of DUNE Far Detector Dual Phase geometry

d. Continue to work on old issues while keeping up with new ones.