Simulation
(input for the software review talk)

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Overview

Simulation goal

- Study figure-of-merit for experiments
- Optimize detector designs for experimental needs
- Understand experimental conditions and mitigate technical risks.

Design philosophy:

- Use modern simulation package
- Have flexible event input for stand-alone generators
- No hardcoding detector description
- Have standard set of output
- Avoid reinventing the wheel

SoLID_GEMC

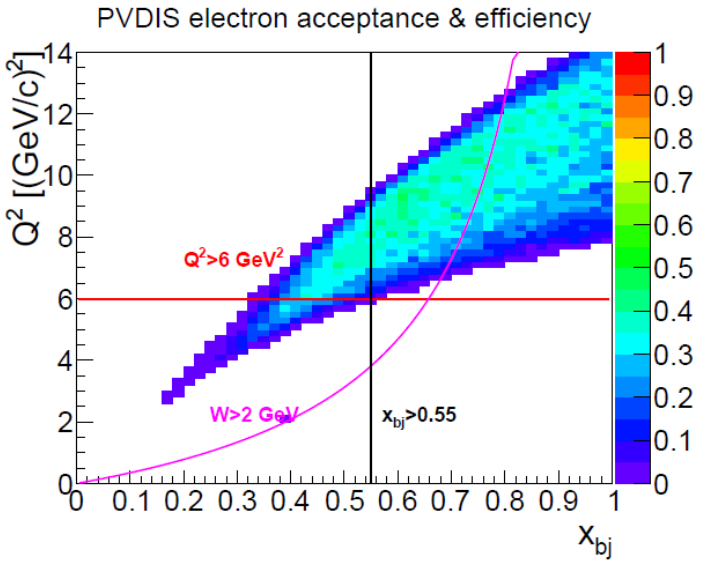
- Based on GEMC (GEant4 Monte-Carlo)
  - gemc.jlab.org
  - c++ framework that uses geant4
  - External Detector description with cad/gdml imports
  - Customizable detector output
  - Used by CLAS12 official simulation, strong jlab inhouse support

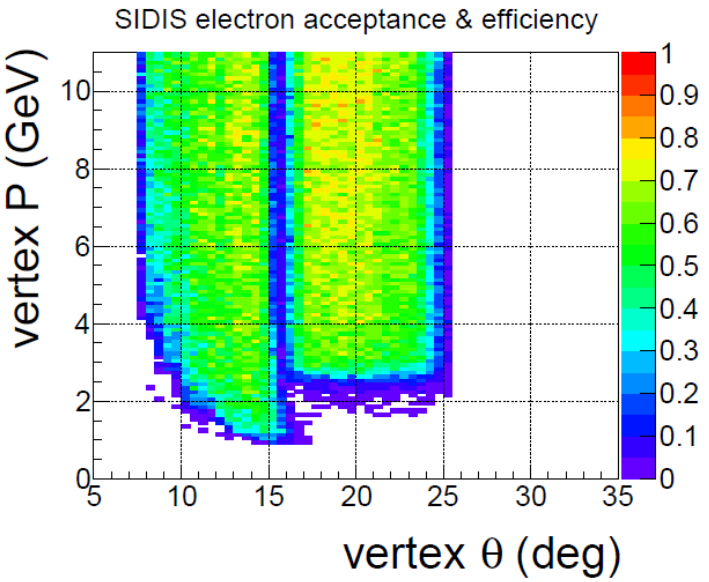
SoLID_GEMC

- SoLID_GEMC
  - Use external generator with standard interface
  - Detector description and detector output defined externally
  - Seamless integration between standalone subsystem and overall simulation
  - Standard output among all subdetectors
  - Modular analysis for all subdetectors to form overall analysis results like acceptance, efficiency, trigger

Simulation Details

- A few flash slides showing individual detectors
- Then show overall analysis result





Software Management

- github https://github.com/JeffersonLab/solid_gemc
- Docker images are at jeffersonlab/solid:[tag]
  - SoLID dockerfiles are at https://github.com/JeffersonLab/solid_release

- no installation, one image for any machine, reproducible results
- Build docker image and run with both docker and singularity

preR&D

- GEM simulation, digitization and tracking
- Sub-detector simulation, digitization and reconstruction
- Overall simulation and optimization
- Software framework and integration with simulated data
- General reconstruction

backup

Simulation Software status

- Study for preCDR 2018
  with jlabce 1.3 including Geant4.10.01.p03 and GEMC 2.3
- Try new setup with enlarged magnet endcap
  with jlabce 2.2 including Geant4.10.03.p02 and GEMC latest
  - CAD import
  - Fast MC mode
  - FADC output
  - Background merging
  - 3D map in cartesian coordinates with 4 fold symmetry
  - https://gemc.jlab.org/gemc/html/documentation/releases/changelog.html
- Test GEMC 3.0.beta1
  - multithreading at event level
  - Hit process as plugin
  - Direct root output
  - https://gemc.jlab.org/gemc/html/documentation/releases/roadmap.html

Code on github

Codes are converted from svn to github with history preserved

github https://github.com/JeffersonLab/solid_gemc (alive)

svn https://jlabsvn.jlab.org/svnroot/solid/ (frozen)

Codes are also reorganized with the following struture

- "geometry", detector definition
- "field" field definition
- "script" example script to run simulation
- "digitization" code to digitize simulation output
- "analysis" code to analyze results and do some studies
- "source" source code of solid_gemc which add solid specific hit process routine and load gemc as library
- "mod" some modification of original gemc code to fit solid need

Development rule

- Use "master" branch as devel version and github release as production version
- most small development will be done by "fork->modify->submit pull request" mode.
- some major collaborative development can be done with "branch->modify->submit pull request" mode as needed

event generator will have individual repo (ongoing)

for example "evgen_BHphoton" converted from svn "evgen/genTCS"

Release in Container

- release all software in container
  - Like virtual machine but with no overhead, run farm job, no installation, one image for any machine, reproducible results
  - Build docker image and both docker and singularity
- SoLID dockerfiles are at https://github.com/JeffersonLab/solid_release
- Docker images are at jeffersonlab/solid:[tag]
  - tag 1.0.0 (GEMC 2.3 + solid_gemc 1.0.0)
  - tag 1.devel (GEMC 2.3 + solid_gemc latest)
  - tag 2.devel (GEMC latest + solid_gemc latest)
- Running it on jlab farm is working (instruction soon)
- Running it on open science grid is feasible (instruction in near future)

Event generator

- done
  - hadron generator “solid_bggen” (halld “bggen” based) code improvement and bug fix (Ye Tian, Jixie Zhang)
  - Comparing solid_bggen and pi- rates from MARATHON pi0 rates (DVCS?)
  - SIDIS generator (Tianbo,Zhihong)
- Todo
  - Comparing solid_bggen and pi0 rates from DVCS (Ye Tian from Shandong Univ.)
  - Internal and external radiative effects
  - check and compare inclusive ele generator “solid_inclusive_e” (Christy/Bosted+LHAPDF6) and “eicrate” (Seamus)
  - Finalize jpsi generator (Sylvester)

Magnet

- done
  - New magnet 3D field map (Jay)
  - NH3 target magnet field map fixed (Chao Gu)
  - Read new magnet 3D field map in simulation (Zhiwen)
- todo
  - Study how map grid size and precision affects tracking resolution to understand tracking requirement on map (Jinlong?)

Baffle

- done
  - Optimization study (Rich)
  - Recheck with new magnet (Rich)
- todo
  - 32 instead of 30 sectors (?)

Target

- done
  - Detailed NH3 target in simulation (Chao Gu)
- todo
  - He3 window collimator optimization (Zhiwen)

EC

- done
  - add scintillation (Birk) and fiber attenuation effect for shower and preshower (Zhiwen Zhao, Ye Tian)
  - Trigger function (Ye Tian)
  - Simulation for beam test (Ye Tian)
  - Study combine 3 readout into 1 (Ye Tian)
- todo
  - comparing to test result (Ye Tian from Shandong Univ.)
  - new FAEC layout for new magnet, LAEC layout (ANL)

GEM and tracking

- Done
  - digitization and tracking tested for 160ns time window of SAMPA chip for SIDIS He3 (Weizhi)
  - digitization and tracking note in docdb (Weizhi)
  - digitization for PVDIS with strip cut (Rich)
  - Study one plane removed (Jinlong)
- Todo
  - Add layout and dead area (UVa?)
  - Test SAMPA chip with 80ns for SIDIS He3 (Jinlong)
  - Recheck PVDIS tracking with strip cut (Jinlong)
  - Test SAMPA chip for other setup
  - Optimize SIDIS and JPsi setup
  - Optimize digitization code
  - SIDIS NH3 tracking
  - Get Resolution with background for all setup with better description

MRPC

- Done
  - digitization improved
- todo
  - Comparing to data
  - Finish occupancy and rate study
  - Study trigger condition and trigger response

Sanghwa

SPD

- Done
  - More detailed digitization including light collection
  - add scintillation (Birk) effect
- todo
  - Comparing to data
  - Finish occupancy and rate study
  - Study combined trigger response with MRPC

Sanghwa

HGC

- done
  - redesign optics for new magnet (Bo Yu,Zhiwen)
- todo
  - Study field effect
  - Background and window study
  - Study small flat mirror

LGC

- Done
  - Optimize more forward angle for SIDIS
  - Study small flat mirror
- Todo
  - More optimization for new magnet

Overall simulation

- Done
  - NH3 acceptance file with correct field map (Zhiwen)
  - Trigger and background with new hadron generator output for SIDIS He3 (Ye Tian)
- Todo
  - DAQ deadtime simulation
  - Trigger and background with new hadron generator output for other setup
  - Background merging and pileup for all detector
  - End-to-end simulation with all digitization

Digitization and reconstruction

- Digitization (keep it independent of simulation)
  - MRPC and GEM digitization are most advanced, they are after simulation. For other detectors, we could do the same
  - In simulation, Cerenkov record photons, SPD and EC record energy deposition, then in digitization, convert Cerenkov,SPD,EC to number of p.e., unless it can't be separated
  - This would save a lot of simulation time
- Reconstruction
  - Tracking code is independent
  - We have simple root script to read simulation output and combined information from many sub-detectors to study acceptance,efficiency,trigger etc and produce some plots and numbers
  - Simple code can't go too far
- Next step
  - Maybe try to use art with a data model and input plugin to read GEMC output, then code can still be reused even for next stage of simulation.
  - Do GEM digitization in art to test drive data model,input plugin, etc (?)

Priority

- Before jlab internal review
  - Refine current study
- Before DOE review
  - Comparing solid_bggen and pi0 rates from DVCS (Ye Tian from Shandong Univ)
  - SAMPA chip and tracking (Jinlong)
  - MRPC and SPD rate study (Sanghwa)
- Beyond
  - Set up all sub-detectors with enlarged magnet endcap to start another round of overall simulation