SoLID Simulation Overview

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2021/12

Simulation software

- Solid_gemc
  - Have been using Jlab_version 1.3m (gemc 2.3 and Geant4.10.01.p03)
  - New Jlab_version 2.5 (gemc 2.9 and Geant4.10.07.p03)
    - Container released
    - Solid_gemc updated to work with the new release
    - Testing full simulation to produce files for longer endcap study
  - Stay with gemc2 until a clear direction for general software framework
- Gemc news
  - gemc3 (latest geant4,multithreading,streaming readout) is in good shape
  - gemc2 will enter maintenance mode
  - Clas12 plans to move to gemc3 by summer or fall 2022

Simulation Tasks

https://solid.jlab.org/wiki/index.php/SoLID_Study

	description	who	status
1	Cherenkov simulation for preRD to support test	Zhiwen, Michael	background rejection
2.1	GEM digitization with VMM and tracking	Weizhi	summary
2.2	GEM frame,dead area,layout in the simulation and update tracking for initial study	Weizhi, Zhiwen	summary
2.3	SIDIS_NH3 electron tracking, SIDIS_He3 hadron tracking, Initial tracking for multiple particles	Weizhi	finished
3.1	check longer endcap setup: acceptance	Zhiwen	ongoing
3.2	check longer endcap setup: EC edge effect	Ye Tian	Finished
3.2	LAEC performance at 15 deg and if we need shorter modules	Ye Tian	ongoing
3.3	EC digitization	UIC	ongoing
4	check longer endcap setup: background and trigger with existing method (PVDIS, SIDIS_He3)	Ye Tian	ongoing with updated generators
5	JPsi, background and trigger	Sylvester	same trigger rate limit like SIDIS, still need some study
6	SIDIS_NH3, background and trigger	Vlad	Finished for shorter endcap
7	evaluate e- and hadron generators and compare to Geant4	Ye Tian	Ongoing

SoLID with AI/ML

- Topics
  - Improve tracking and data reduction
    - GEM clustering and tracking efficiency and speed
  - Improve PID
    - Ecal and Cherenkov individually, then combined
    - TOF
  - Combine all detectors for overall performance
  - Fine tune detector design

- Data science group can help directly beyond just providing tools.
- Solid needs to provide connection between data and tools

Q&A with data science group

https://solid.jlab.org/cgi-bin/private/DisplayMeeting?sessionid=127

SoLID	Tracking	Cherenkov	EC
1. What are we trying to do? Articulate the objectives of the 3 efforts. * Including the figure of merit	improve the performance of GEM clustering improve the performance of tracking reconstruction	Improve Cherenkov PID beyond simple Npe cut. For HGC with background , efficiency (> 90%) and rejection (>10) Improve LGC with trigger design	Improve EC PID performance with background. We want to keep pion rejection > (50:1) with electron efficiency>90%.
2. Explain what is done today, and what are the limits of current practice? (baseline)	Not much	Not much, start to explore AI simple Npe cut performance degrade with high background	Not much. the traditional cuts couldn't keep the pion rejection as high due to energy leak at edge
3. If we are successful, what difference will it make?	a few times improvement on the speed and around 10% improvement on the tracking reconstruction efficiency and accuracy. GEM clustering will benefit SBS also	Improve Cherekov performance baseline at high background Help with readout choice to determine if pixel/quad/sum are needed	significantly improve the ECAL PID performance at the edges of EC
4. Data available (raw and simulated) * File format (root?) * Data format and variable summary (tabular?) * Data size (number of samples?) * Where is the data located? When can we have access?	Unlimited simulation data in root or text format available on ifarm as soon as we agree on a format	Unlimited simulation data in root or text format Both low rate and high rate data from HallC test (~10 thousands events) Cosmic with background data from bench (~thousands events) available on ifarm as soon as we agree on a format	Unlimited simulation data in root or text format Some low rate real data from Fermi lab test (~thousands events) available on ifarm as soon as we agree on a format
5. Timeline? * Publications/conferences?	Not sure	Working on note/short paper about readout aiming for next year. AI would be a nice part of it or a separated paper	Not sure
6. Who is available to work on this with the data science dept.?	Weizhi Xiong until Feb, someone else afterwards	Zhiwen Zhao, Bo Yu, Michael Paolone	Ye Tian, Zhenyu Ye

HGC FOM

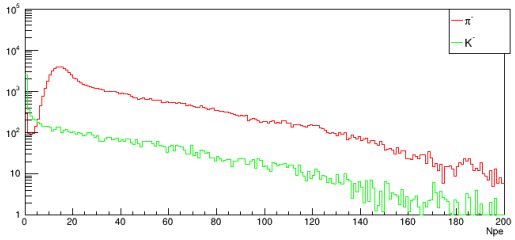
- HGC performance can be judged by the following figure of merit:
  1. FOM pion:
     efficiency =(Nevent of >Npe)/Ntotal
  2. FOM kaon:
     1-1/rejection = (Nevent of <Npe)/Ntotal
- Hope to have both FOM reach 0.9 at the same time

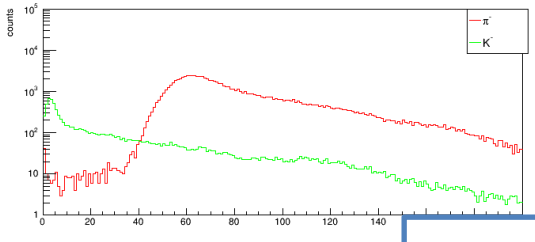
FOM	P=2.5GeV, Theta=8deg	P=7.5GeV, Theta=14.8deg
No background	0.93	0.92
"1 sector" background	0.77	0.86
"2 sector" background	0.64	0.80
"3 sector" background	0.57	0.78

P=2.5GeV, Theta=8deg

P=7.5GeV, Theta=14.5deg

count

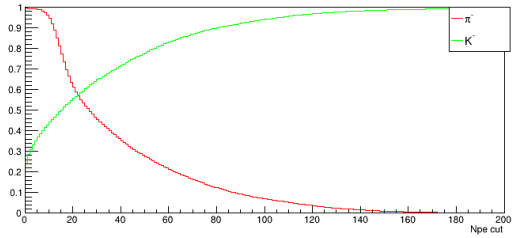


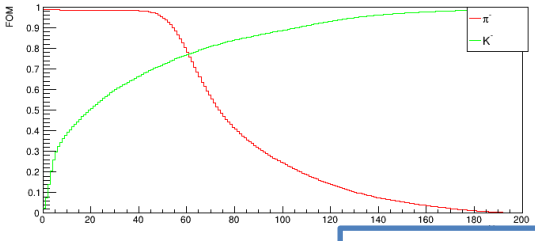


"3 sector" background

Npe

FOM





Npe cut

Go beyond Npe cut to use location info with AI/ML

HGC data format

- Basic info
  - Event recorded in 3 sectors (for solid sim), each sector has 16 pmt in 4x4 array, each pmt can have readout by pmt/quad/pixel
  - 1 event is made of N=48/192/3072 numbers and each number is the Npe in this pmt/quad/pixel for this event
  - Files are listed for pion and kaon, for different momentum and angle, for with/without background, and for different readout
- File format
  - Text row: 1 event in 1 row
    - row has columns ordered in with readout sensor ID
  - Text matrix: 1 event in 1 matrix
    - matrix has spatial info:
      - Fake spatial: 4*12/8*24/32*96
      - Real spatial: 3 sector in real physical space without many additional 0
  - Any other format without many 0 to reduce file size?
- Sample files at /work/halla/solid/AIML/solid_hgc_sim