GEMC Updates and Prospects

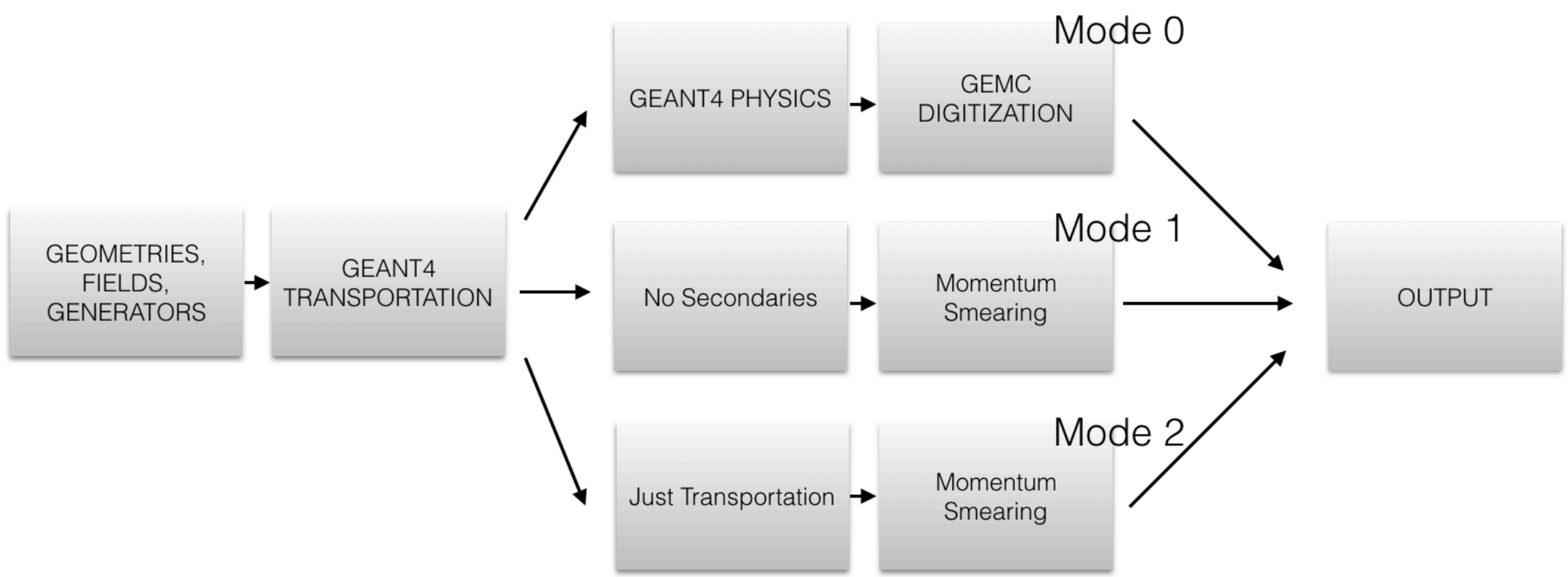
Maurizio Ungaro
Solid Software Simulation Meeting, 3/27/18

GEMC 2.6:

- FASTMC Modes
- CAD, GDML, Native mix and match
- Hit Rejection Mechanism
- GUI:
  - culling buttons
  - show axis
  - detector slices more responsive
- Physics
- Generator
- FADC Mode 1
- Comparison of background with actual CLAS12 running
- Background Merging

GEMC 3 updates

FAST MC Modes



FastMC Modes:

10X faster

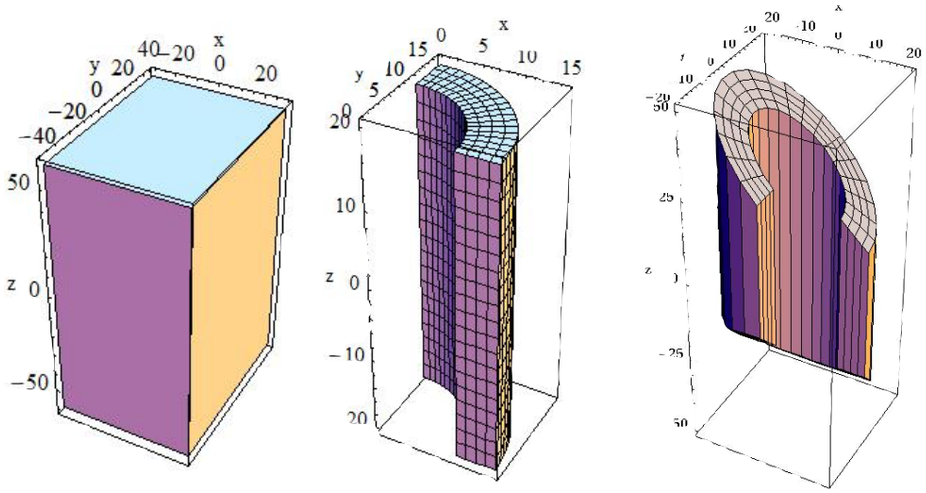
200X faster

1. Mode 0: Full geant4 simulation (default)
2. Mode 1: Turns off secondaries production. Energy loss is still computed, the would-be secondaries just dump all their energy at their producion vertex. All hit process routines are disabled.
3. Mode 2: Turns off all physics except transportation. No energy loss. Force detection of particles passing through detectors. All hit process routines are disabled.
4. Mode 10: Same as mode 1 but with process routines enabled.
5. Mode 20: Same as mode 2 but with process routines enabled.

psmear abstract function mechanism to smear momentum

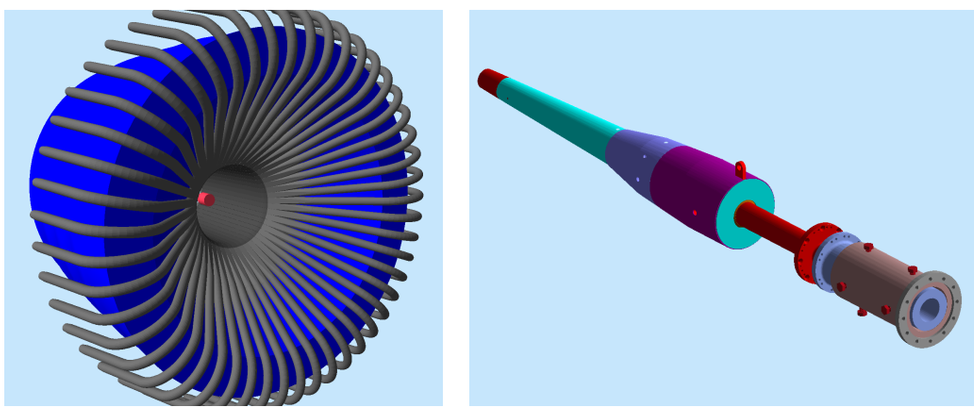
CAD, GDML, Native Mix and Match

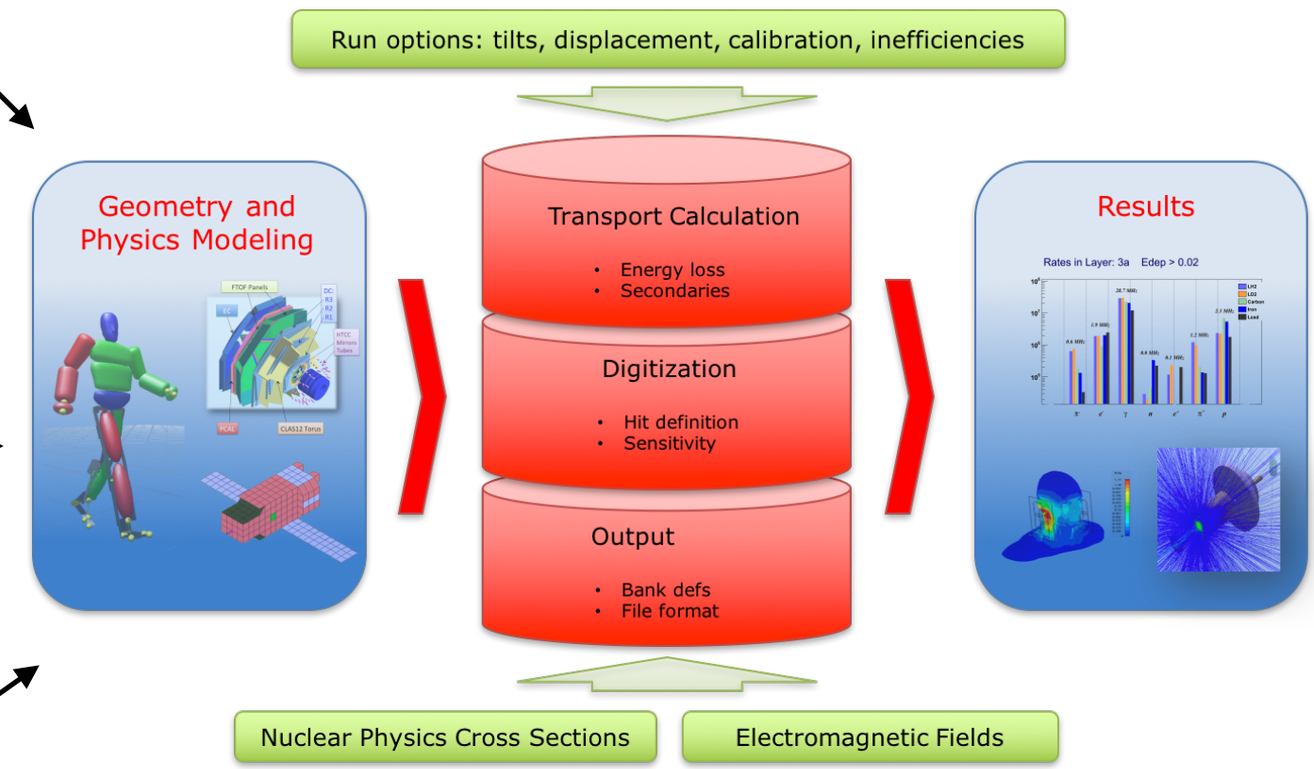
Native



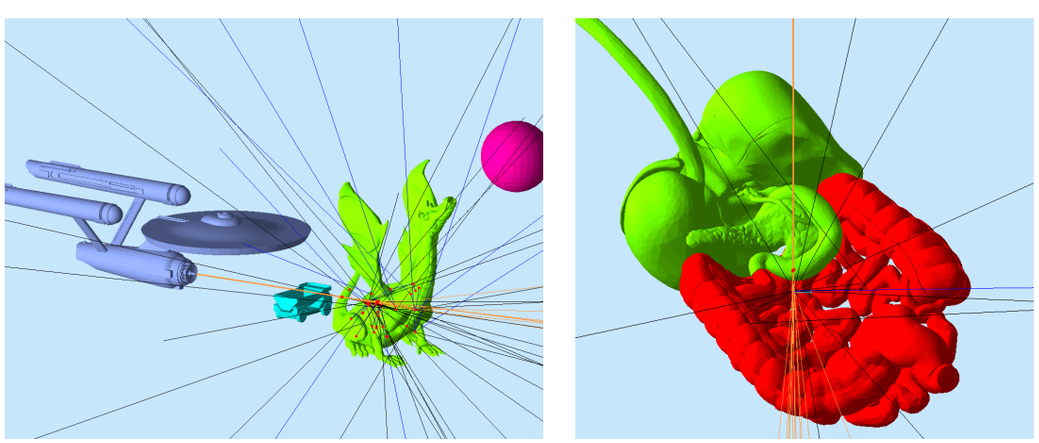
Input: Native, CAD, GDML. Arbitrary hierarchy, can be mixed and matched. Materials, sensitivity assigned at run-time.

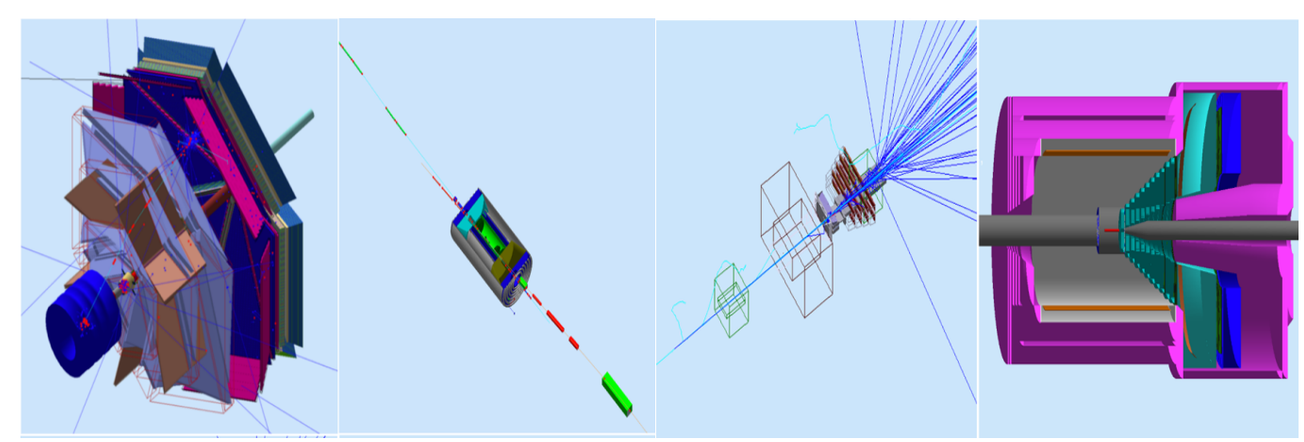
CAD





GDML





Experiments using the GEMC Framework: CLAS12 (Hall-B), EIC Beamline and detectors, HPS, Solid

Hit Rejection Mechanism

rejectHitConditions

Is a boolean variable in the digitization hit process. It can be set to false to skip saving a hit to disk. Examples of reasons:

- threshold
- inefficiency
- bad status
- voltage was turned off

Physics

- added Birk Constant properties in material factory
- adding property sigmaAlpha in optical surfaces
- added sigmaAlpha in verbosity log
- added Birk Constant properties in material factory
- added option G4FIELDCACHESIZE to set the geant4 field cache size.
- added G4SynchrotronRadiation process, off by default, activated with option SYNRAD
- added G4SynchrotronRadiationInMat. SYNRAD option activate that one if it is set to 2.

Generator

Ions generator:

- added option **ION_P**: Option ION_P: Primary particle is an ion. Sets Z, A and Charge State of the primary particle. Setting the charge state is optional.

- Example 1: -ION_P=”6 12” sets the Z to 6, A to 12. Charge will be Z.
- Example 2: -ION_P=”6 12 4” sets the Z to 6, A to 12, and charge to 4.

- Notice: BEAM_P still sets the particle momentum, and its type must be GenericIon. For example:

-BEAM_P=”GenericIon, 4*GeV, 90*deg, 0*deg”

Others:

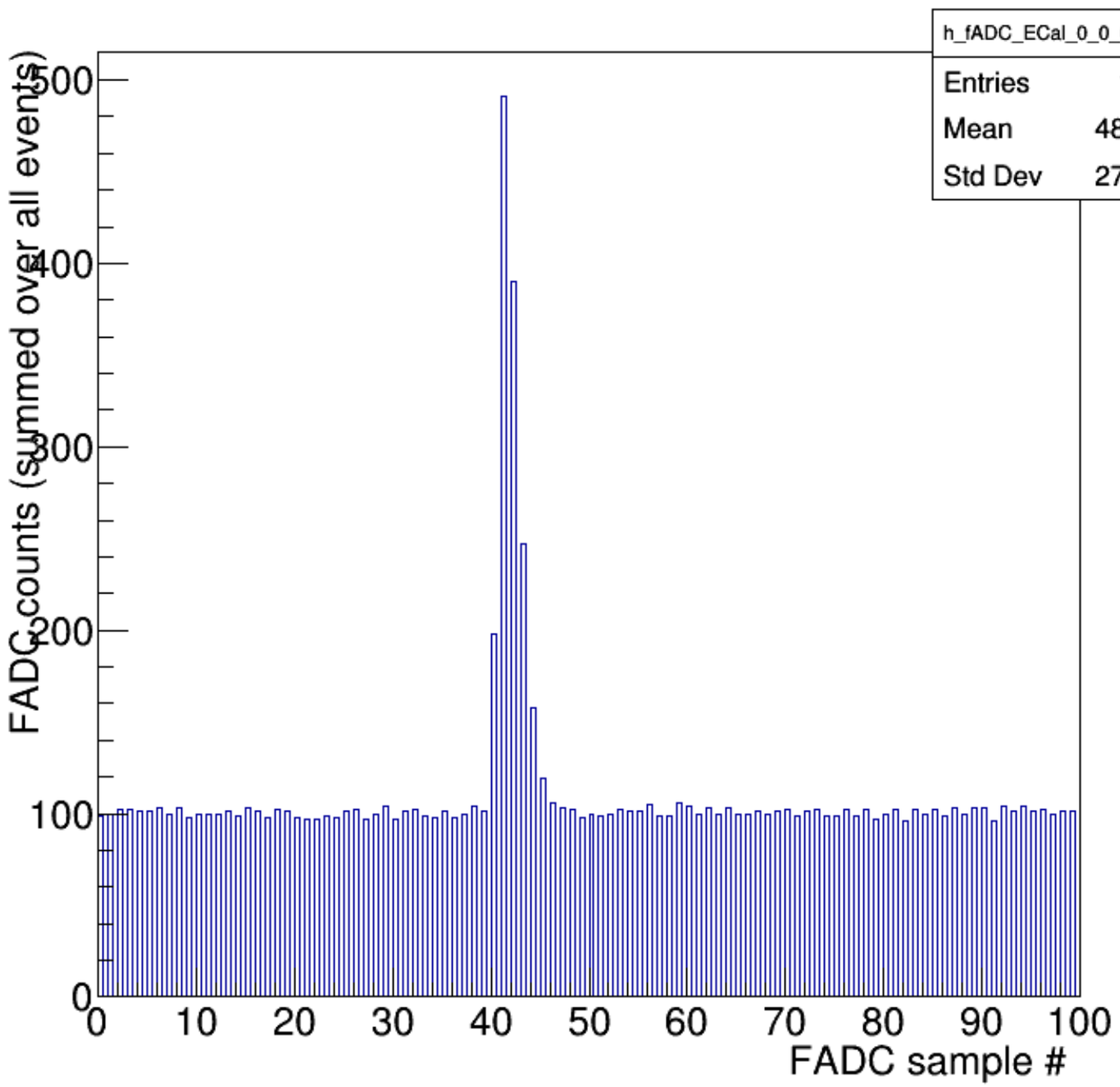
- added beagle open file in primary generator for ascii
- stopping run manager if no more events in the LUND or BEAGLE format
- routine to set generated particle from input file more general
- Maurik Holtrop: fixed vertex spread
- added optional argument (appended at the end) to BEAM_P: “KE” can specify that the momentum is kinematic energy instead. For example, to simulate a K=250 MeV proton:

-BEAM_P=”proton, 250*MeV, 90*deg, 90*deg, KE”

FADC Mode 1

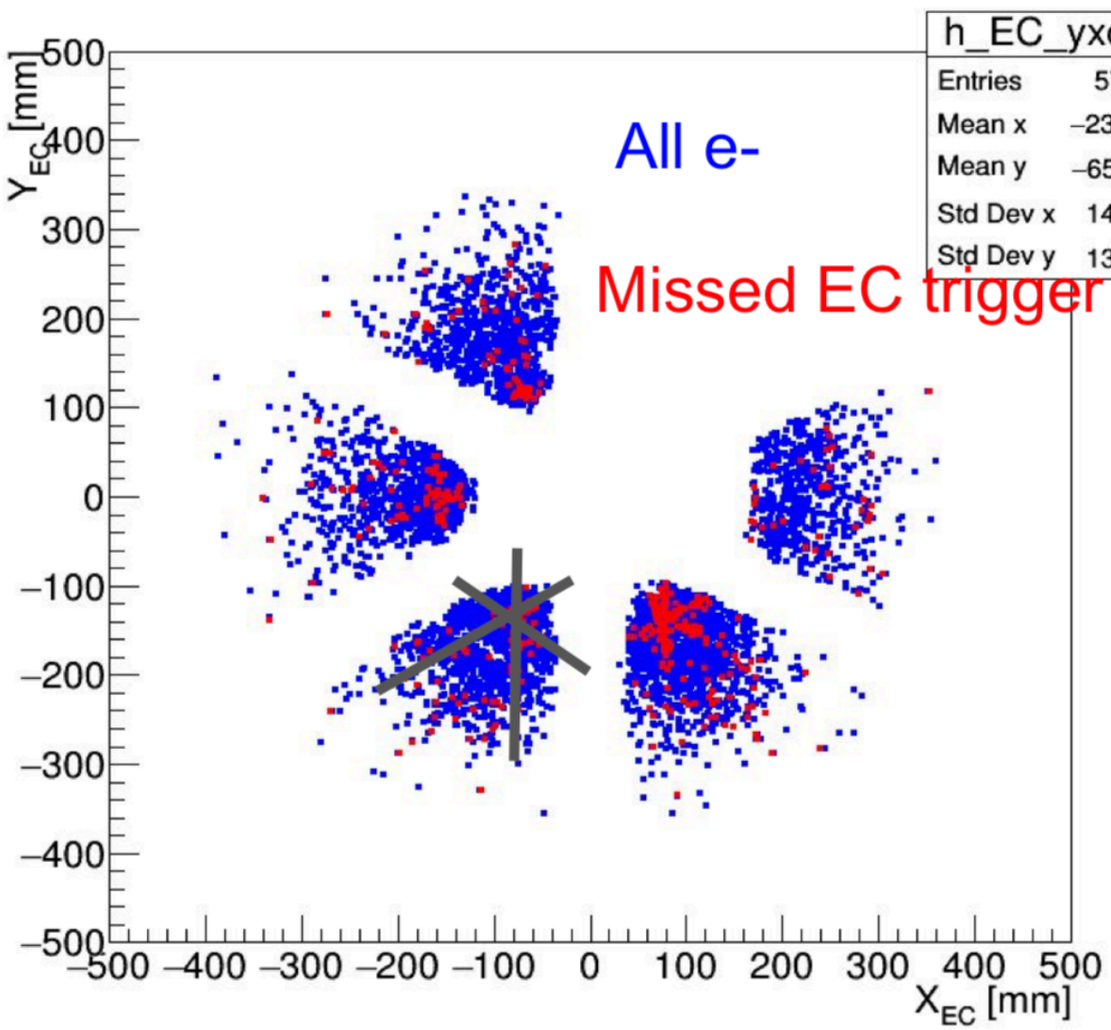
Make Simulation Output IDENTICAL to data

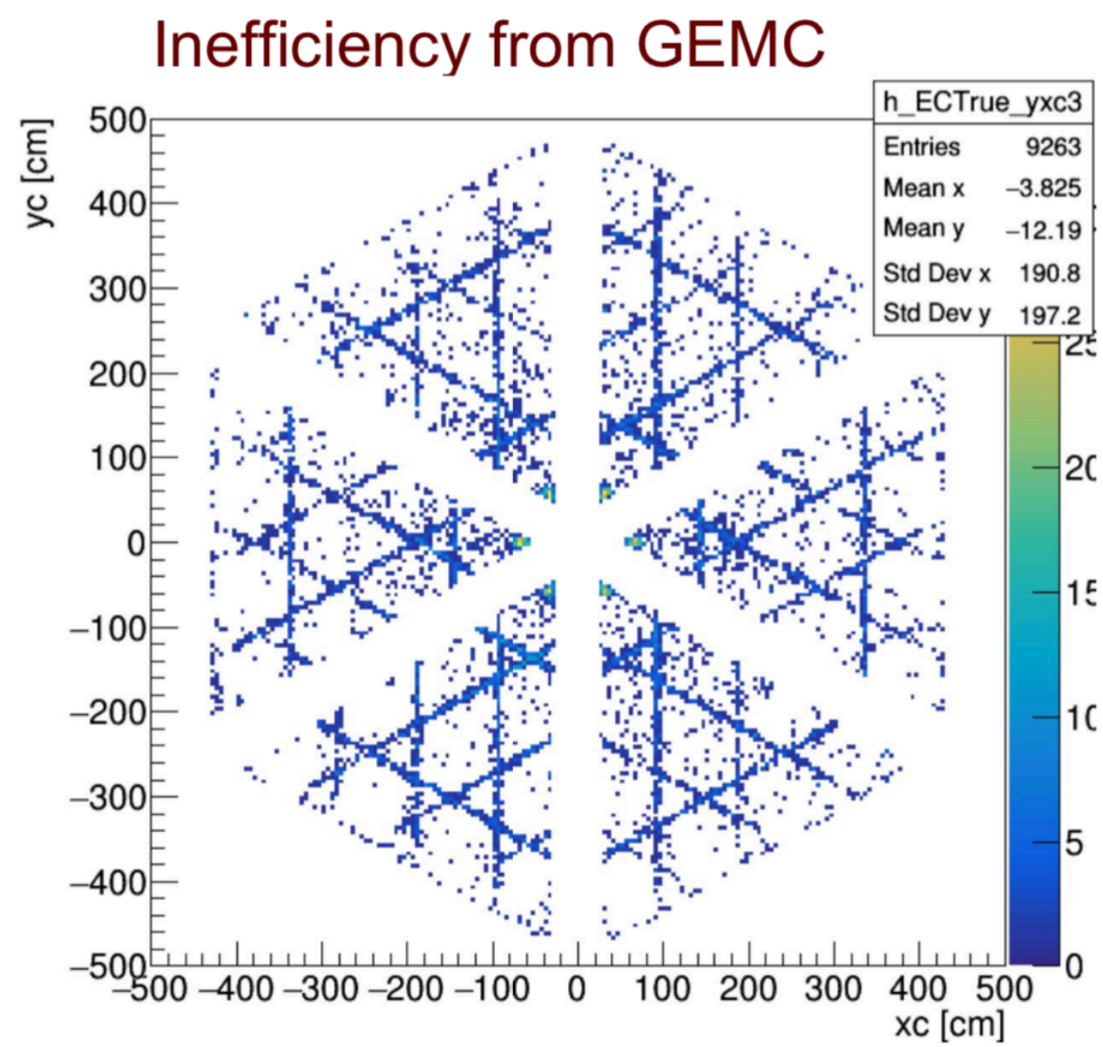
GEMC Voltage Vs Time Factory Method
Translation Tables mechanism in library. Give crate/slot/channel.



- Parameterization of signal for each geant4 step.
- Pedestal mean + sigma
- (100±2), from DB (can come from CCDB)
- Delay can come CCDB
- Can add “wiggles”.
- SAME DAQ Format
- Can be used in DAQ trigger simulator
- Status: EC, PCAL implemented.

FADC Mode 1

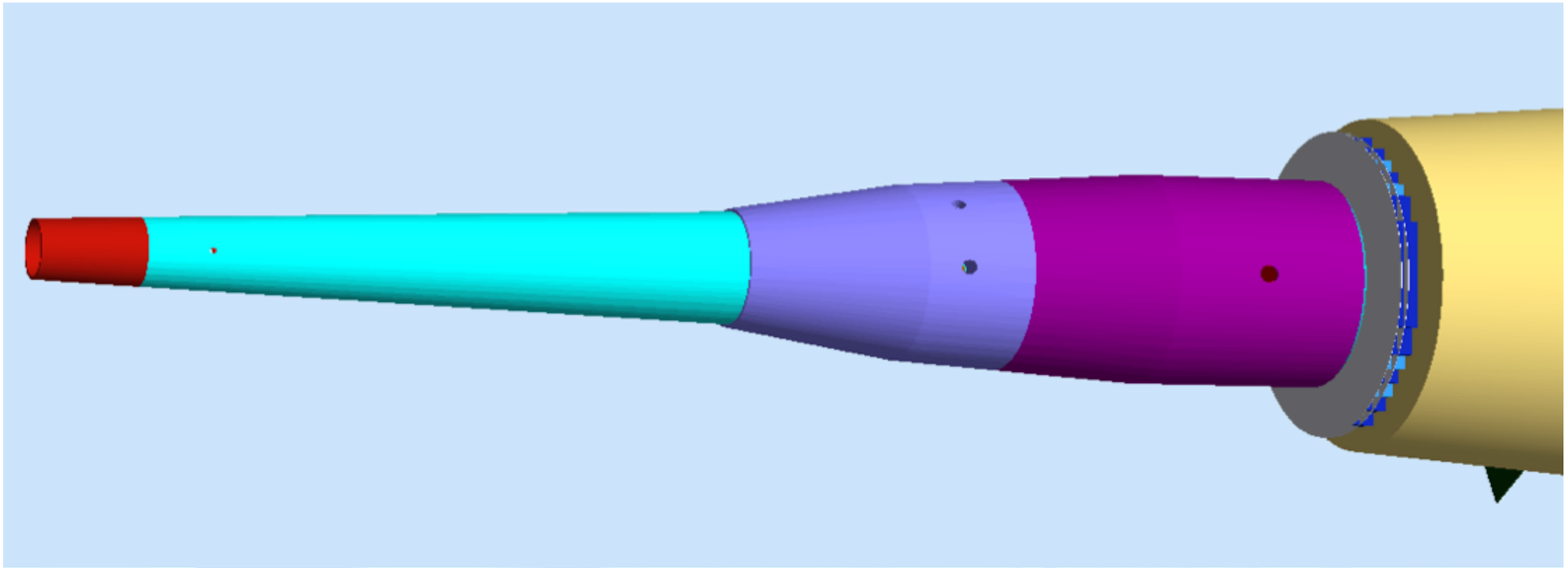


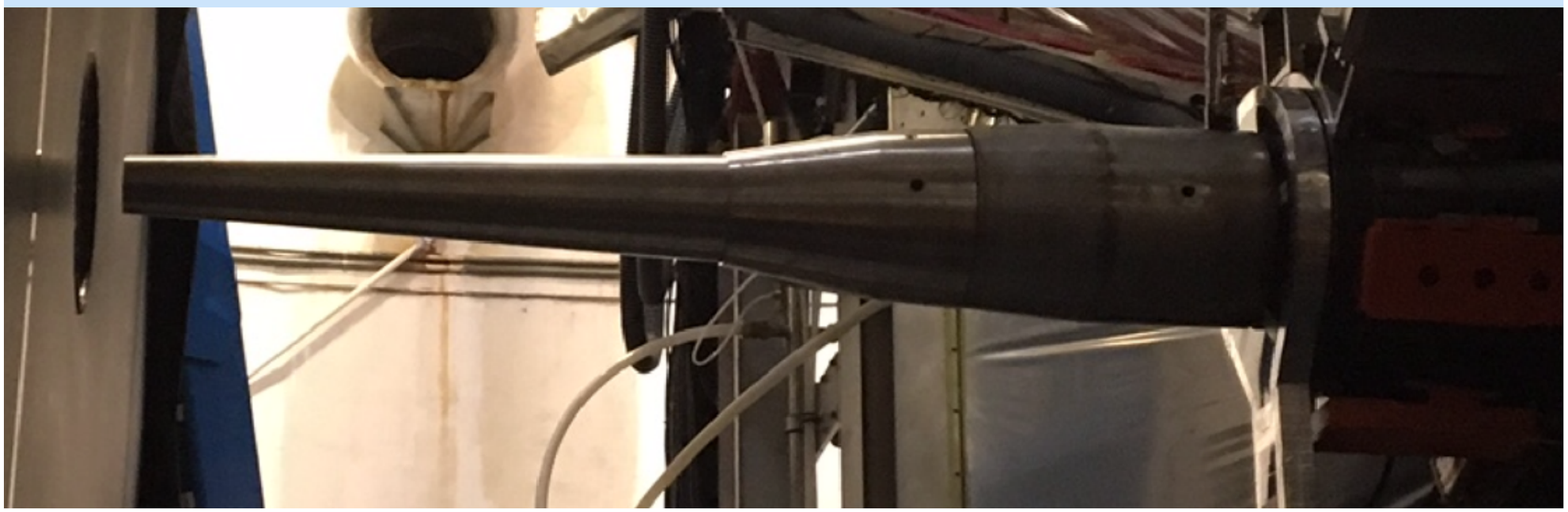


CLAS12 Engineering Run:
Bug in trigger?

Found in GEMC using FADC
Mode 1 fed to FPGA software

CLAS12 Rates vs Simulation





Beamline vacuum, shielding designed to minimize rates on detectors, focus on DC.

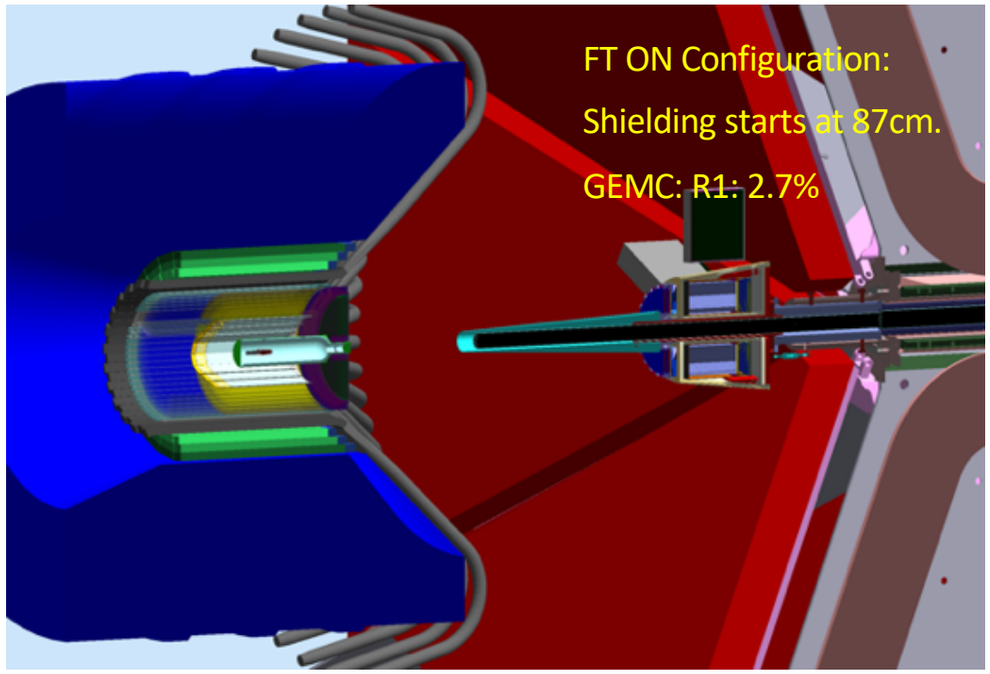
From target, to FT, to inside the torus and downstream of the torus, includes torus cold hub and warm hub components.

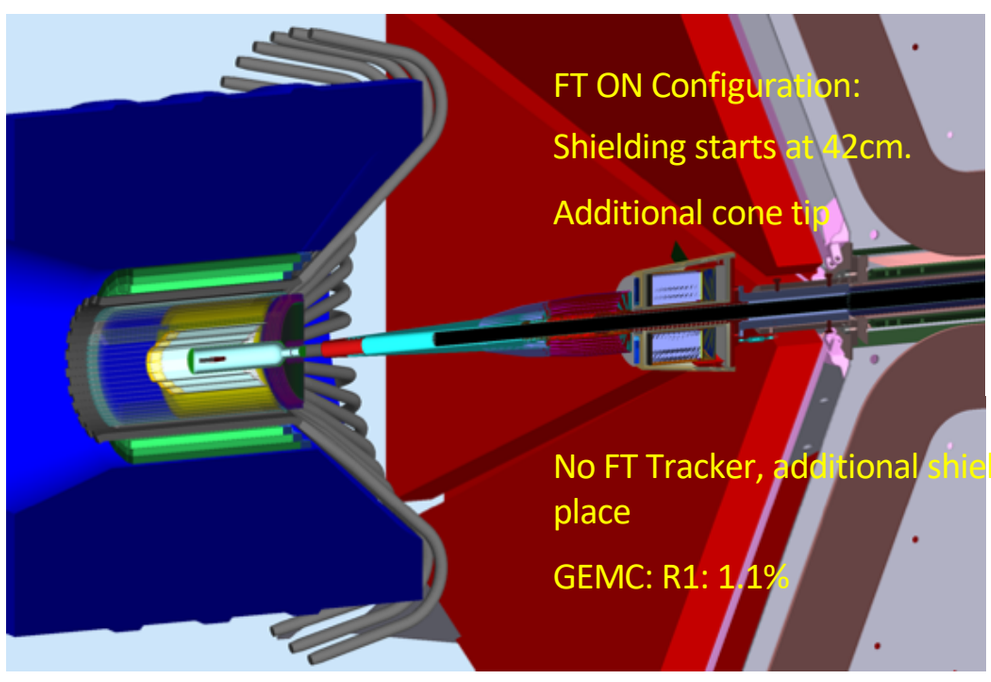
GEMC simulations included CAD imports from engineering models.

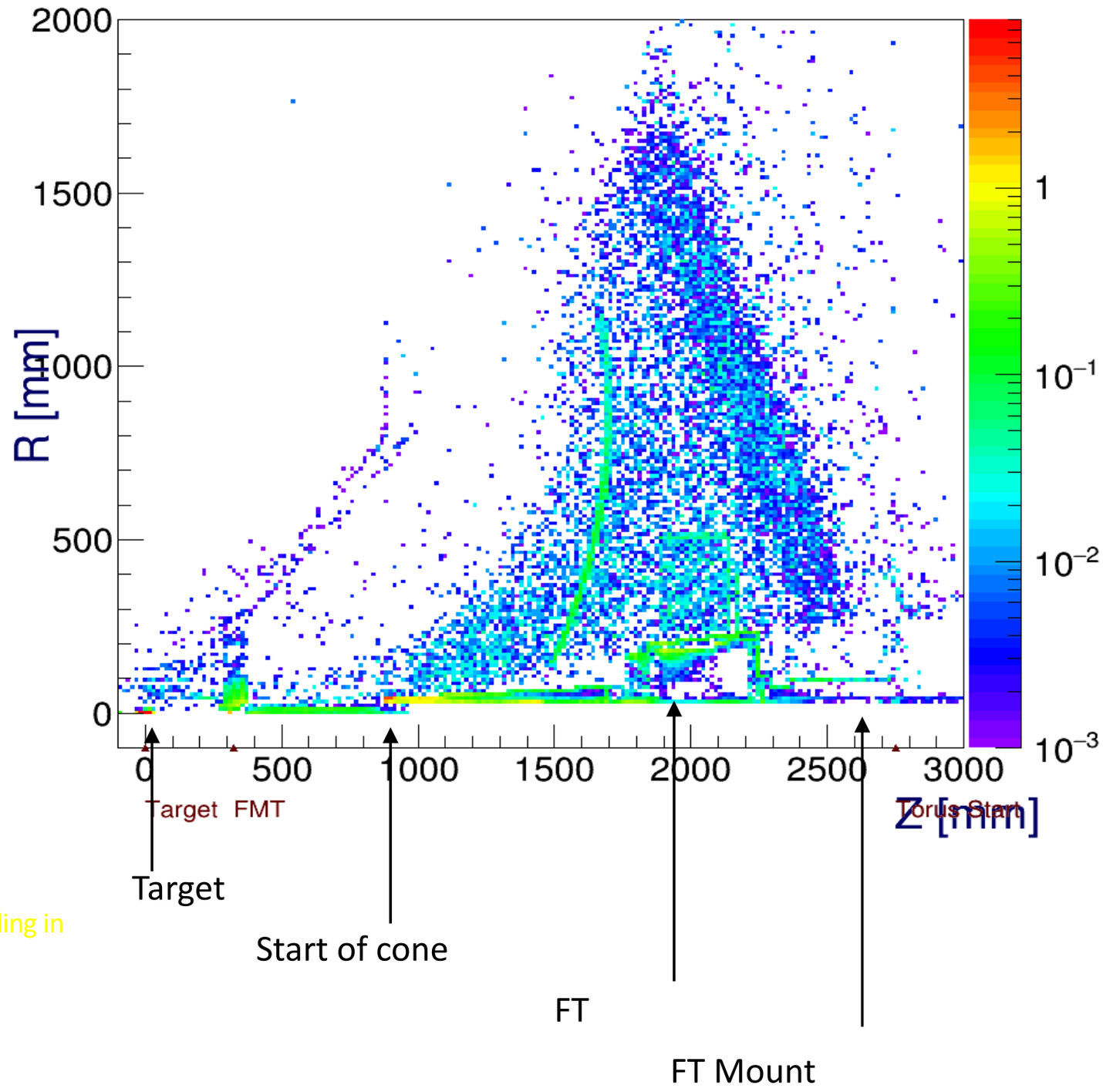
(oops! Beam line was too small!)

CLAS NOTES: 2016-6, 2016-8, 2017-12, 2017-13, 2017-16, 2017-17, 2017-18

CLAS12 Rates vs Simulation





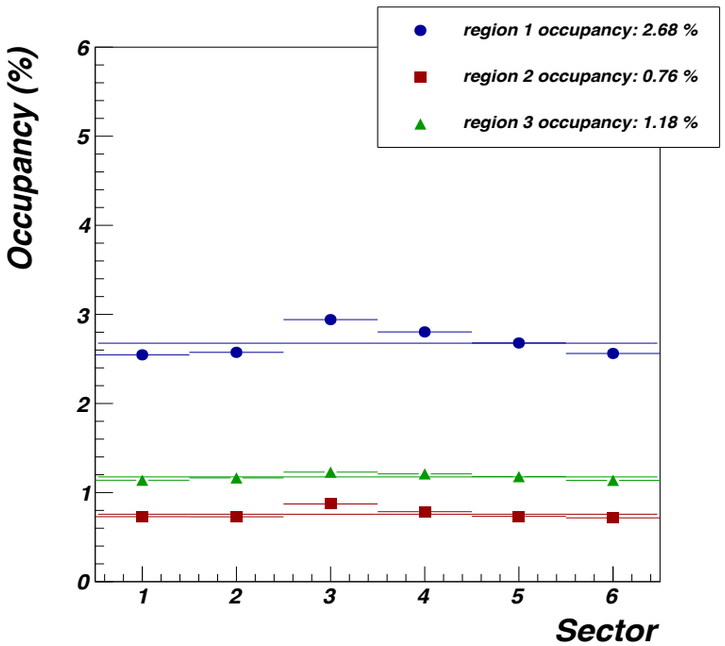


Would be happy to be within a factor of two

CLAS12 Rates vs Simulation

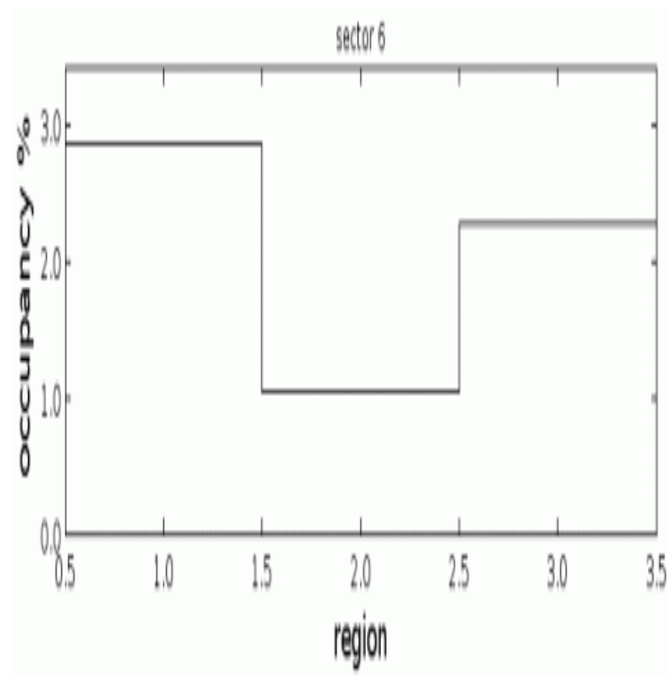
Drift Chambers Rates

GEMC 4a.2.2 at full luminosity

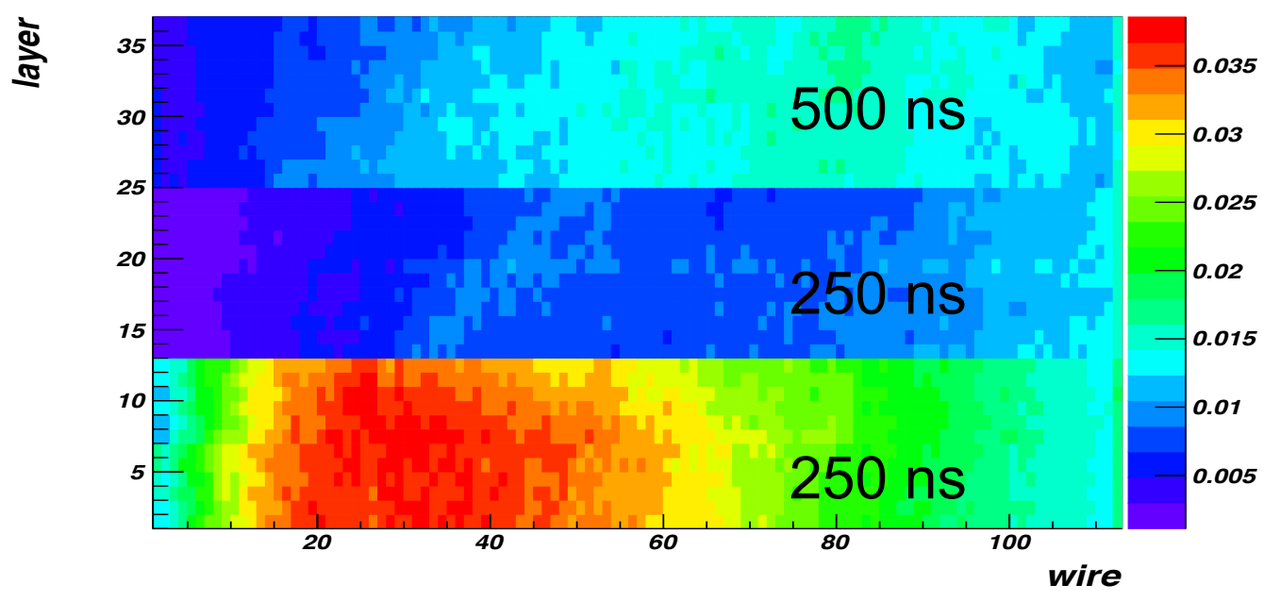


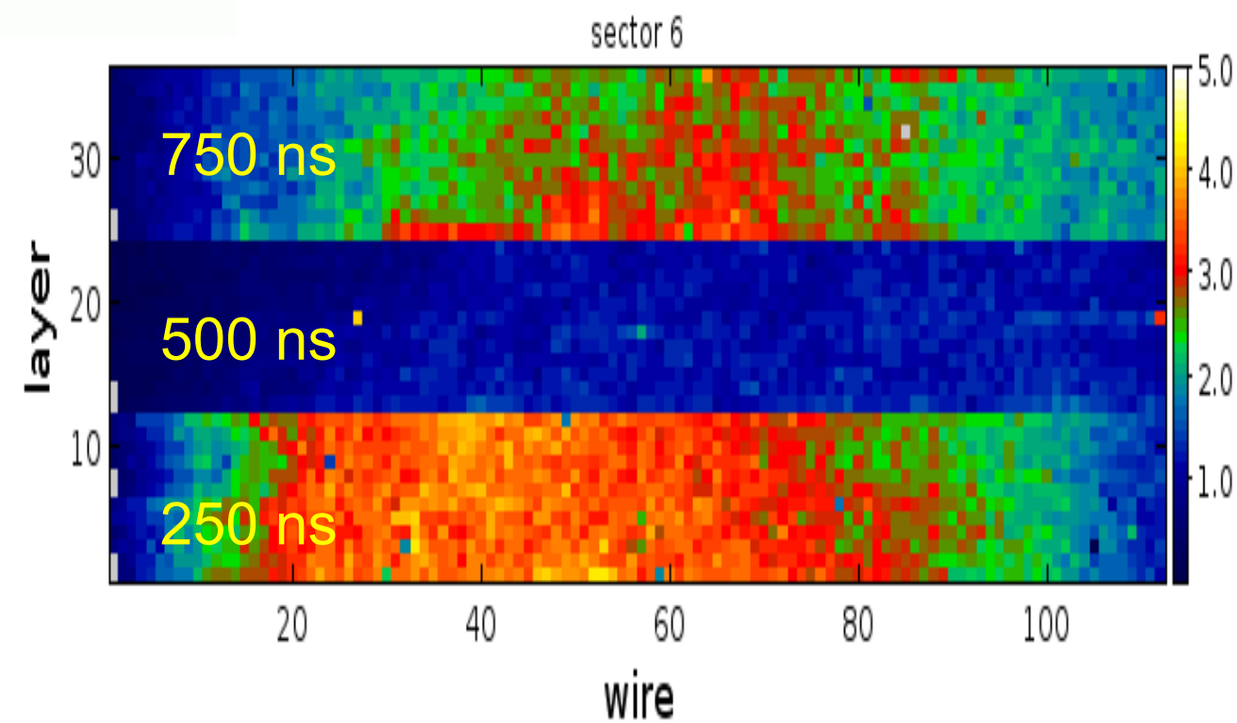
I=75 nA,

luminosity scan on 12/17



	Data (rescaled)	GEMC
R1	2.8 %	2.68 %
R2	0.6 %	0.76 %
R3	1.5 %	1.18 %

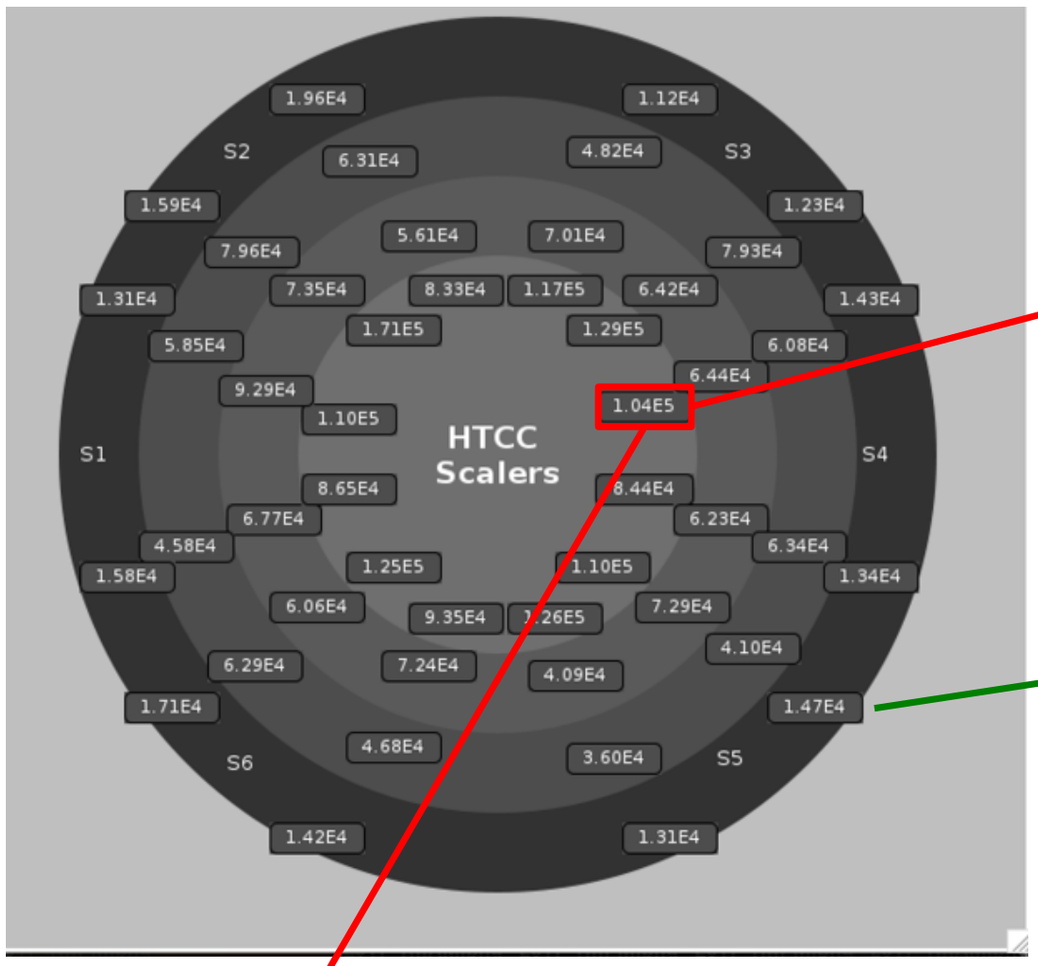




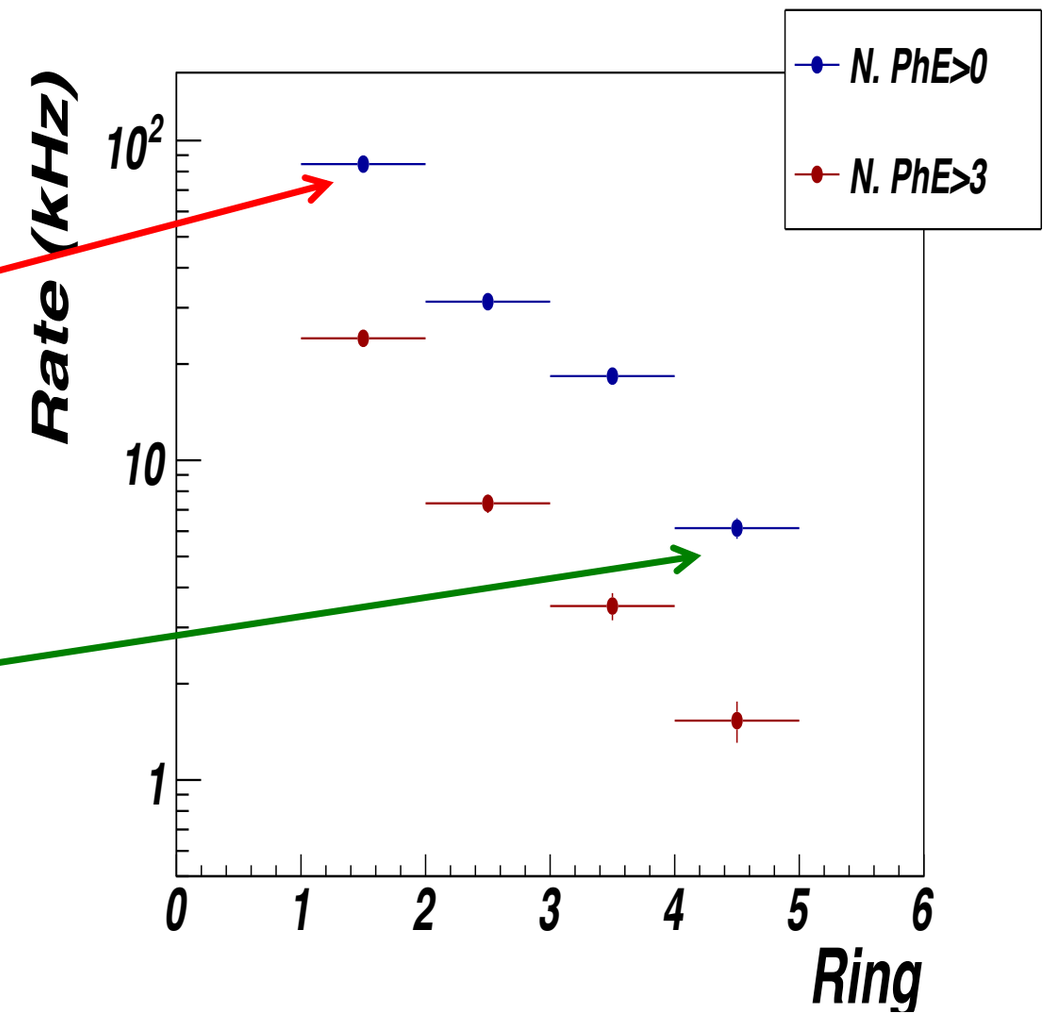
CLAS12 Rates vs Simulation

High Threshold Cerenkov Counter Rates

Data Scalers



GEMC Rates



100 kHz in ring 1 PMTs

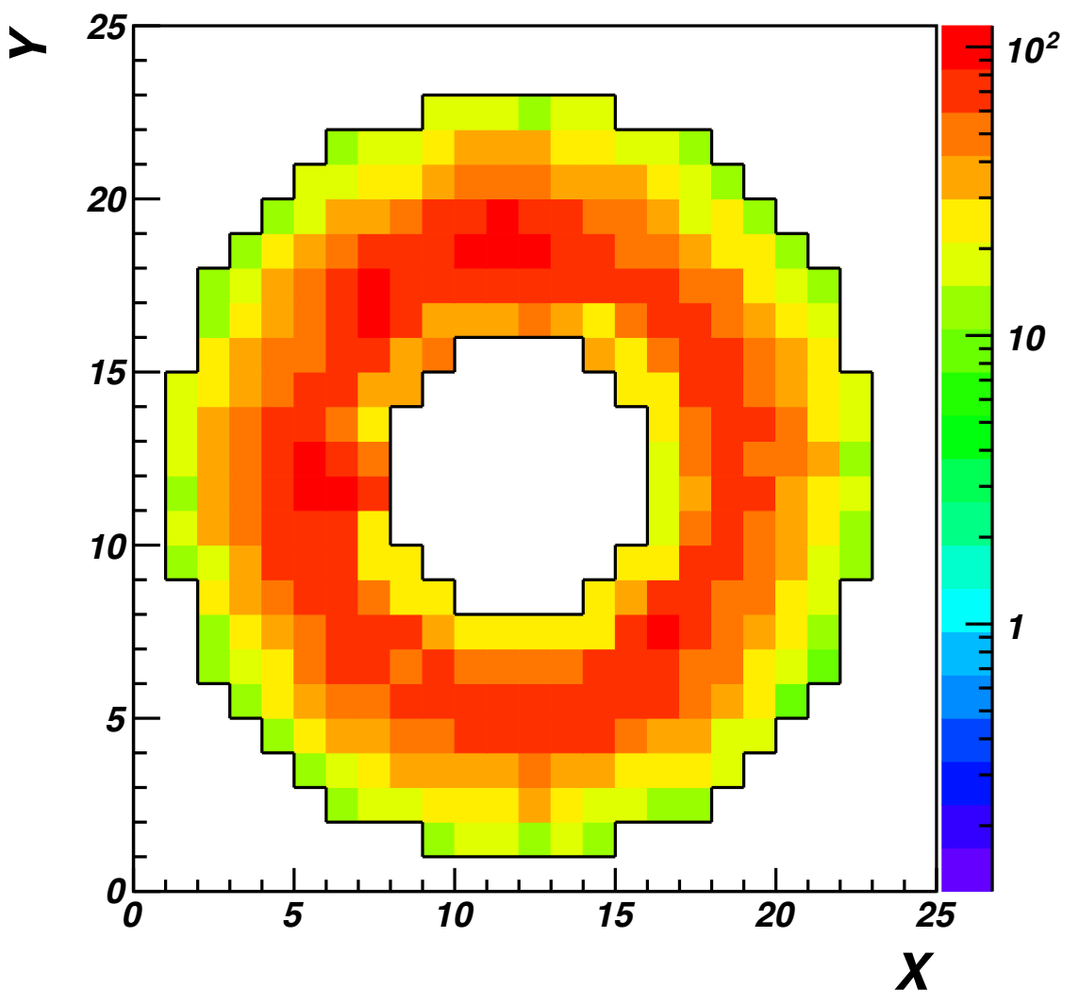
10 kHz in ring 1 PMTs

CLAS12 Rates vs Simulation

Forward Calorimeter Rates

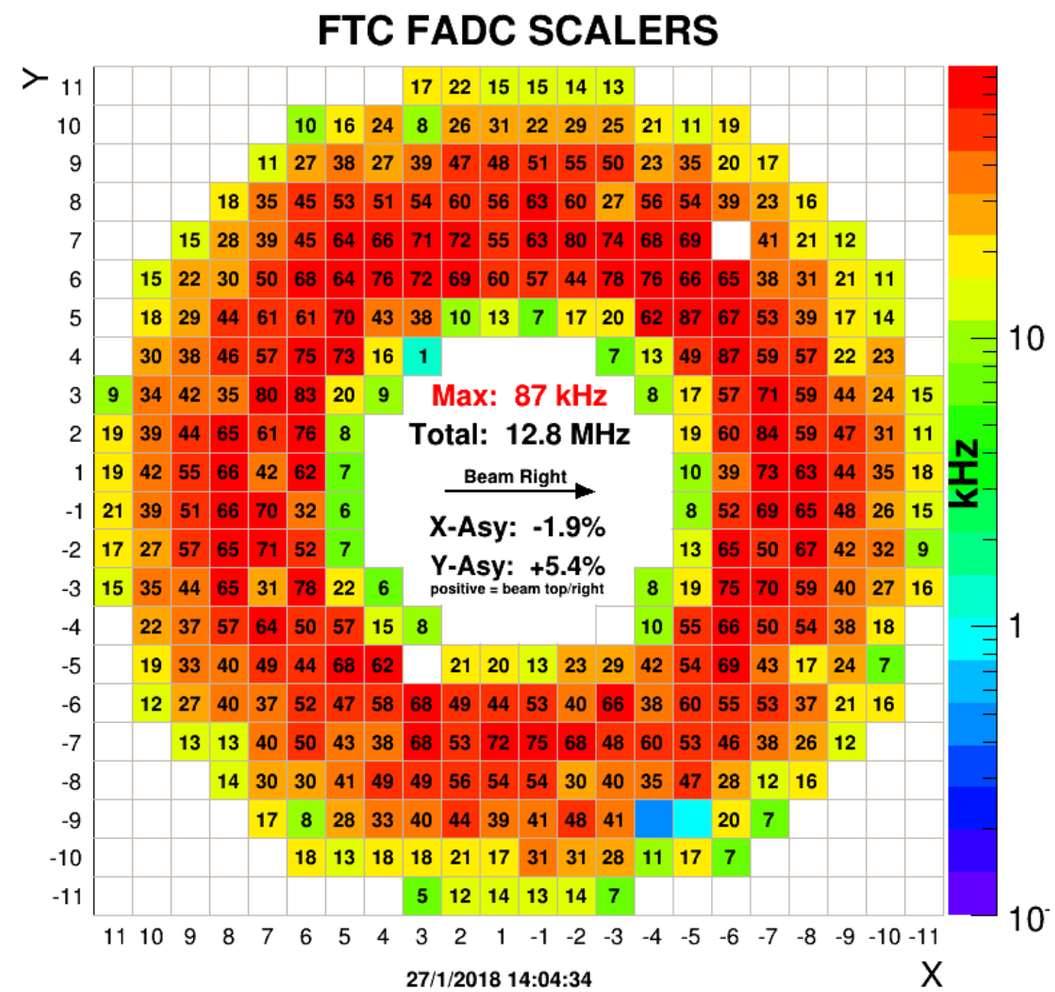
GEMC 4a.2.2 rates:

- Edep>20 MeV
- Full luminosity
- Full solenoid field
- Max rate ~ 100 kHz



Measured rates:

- Edep>20 MeV
- Full luminosity
- Full solenoid field
- Max rate ~ 80 kHz



Background Merging

CLAS12 Note 2018-002

Clas12 luminosity: **$10^{35}cm^{-2}s^{-1}$**

5cm LH2 target, 250ns Time Window: **124K electrons / event**

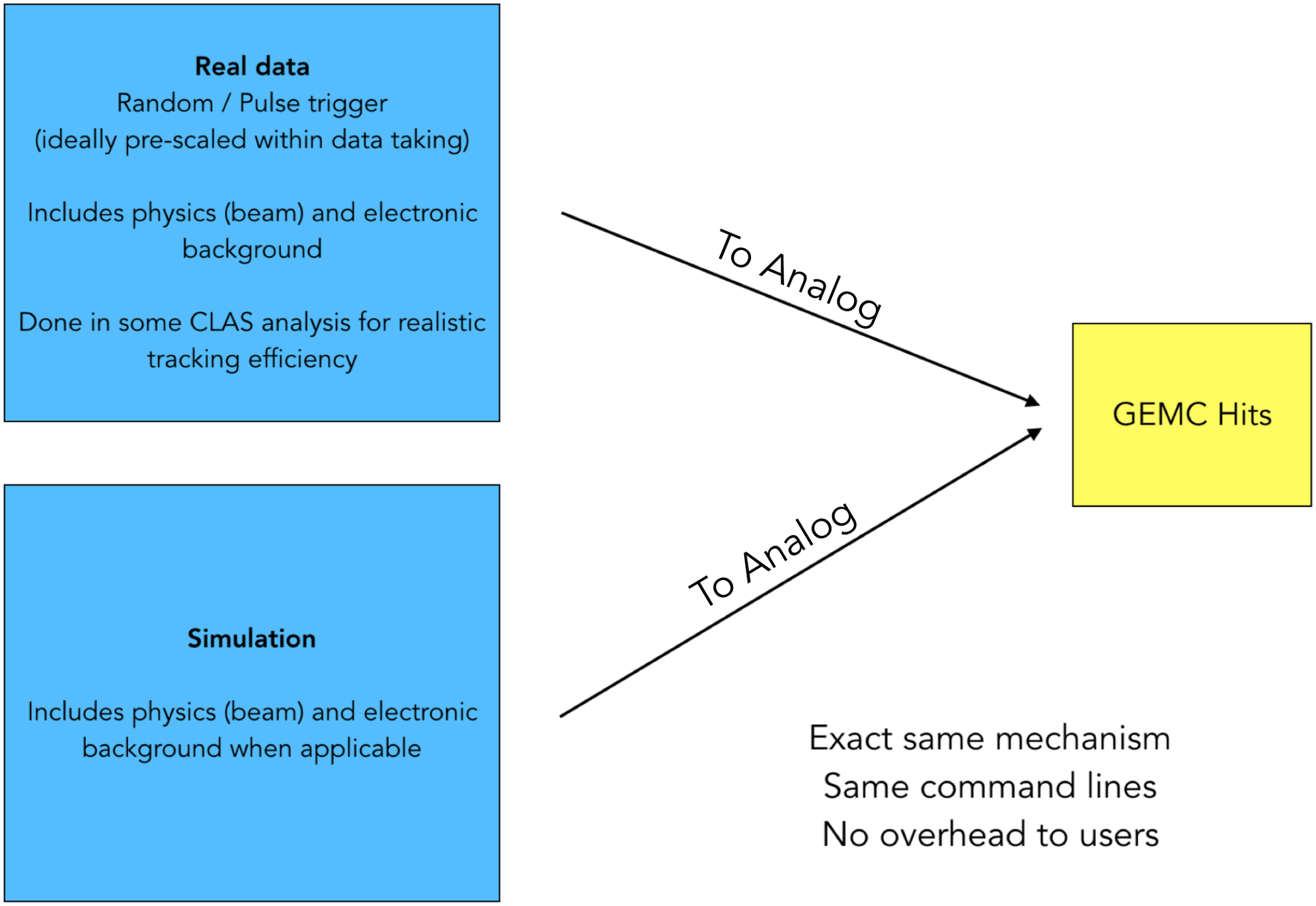
1-2 minutes / event

Prohibitive to get large statistics in reasonable time

$10^{37}cm^{-2}s^{-1}$? Forget about it.

Background Merging

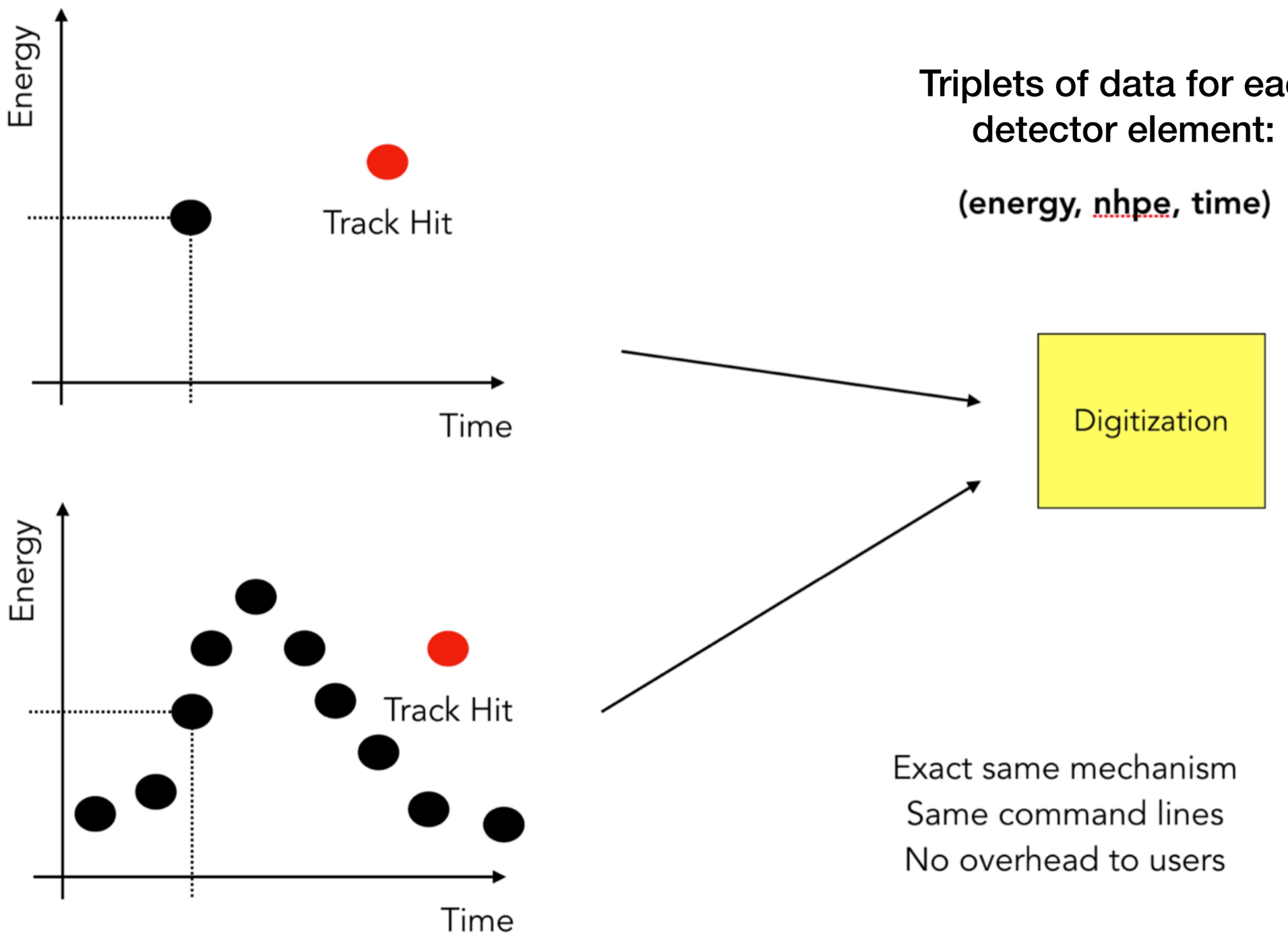
CLAS12 Note 2018-002



"To Analog": custom program that converts ADC and TDC to Energy, Time, nphe

Background Merging

CLAS12 Note 2018-002



Can provide 1 hit or a signal shape. Exact same mechanism

Background Merging

CLAS12 Note 2018-002

dc	1	3	1	1	30	53.000000	0.000000	0.000000
dc	1	3	1	2	30	35.000000	0.000000	0.000000
dc	1	3	1	3	30	149.000000	0.000000	0.000000
dc	1	3	1	3	29	142.000000	0.000000	0.000000
dc	1	3	1	4	30	56.000000	0.000000	0.000000
dc	1	3	1	5	29	43.000000	0.000000	0.000000
ec	1	3	1	1	28	54.000000	0.347000	0.000000
ec	1	3	1	2	46	55.000000	1.369500	0.000000
ec	1	3	1	3	53	56.000000	1.800000	0.000000
ec	1	3	1	1	27	56.000000	2.456000	0.000000
dc	2	3	2	1	36	57.000000	0.000000	0.000000
dc	2	3	2	2	37	130.000000	0.000000	0.000000
dc	2	3	2	3	36	22.000000	0.000000	0.000000
dc	2	3	2	4	36	85.000000	0.000000	0.000000
dc	2	3	2	5	36	98.000000	0.000000	0.000000

Event number

identifier infos

time *energy* *nhpe)*

If “bg.txt” is the name of the file, the syntax for command line is:

-MERGE_BGHITS=bg.txt

while the syntax in the gcard is:

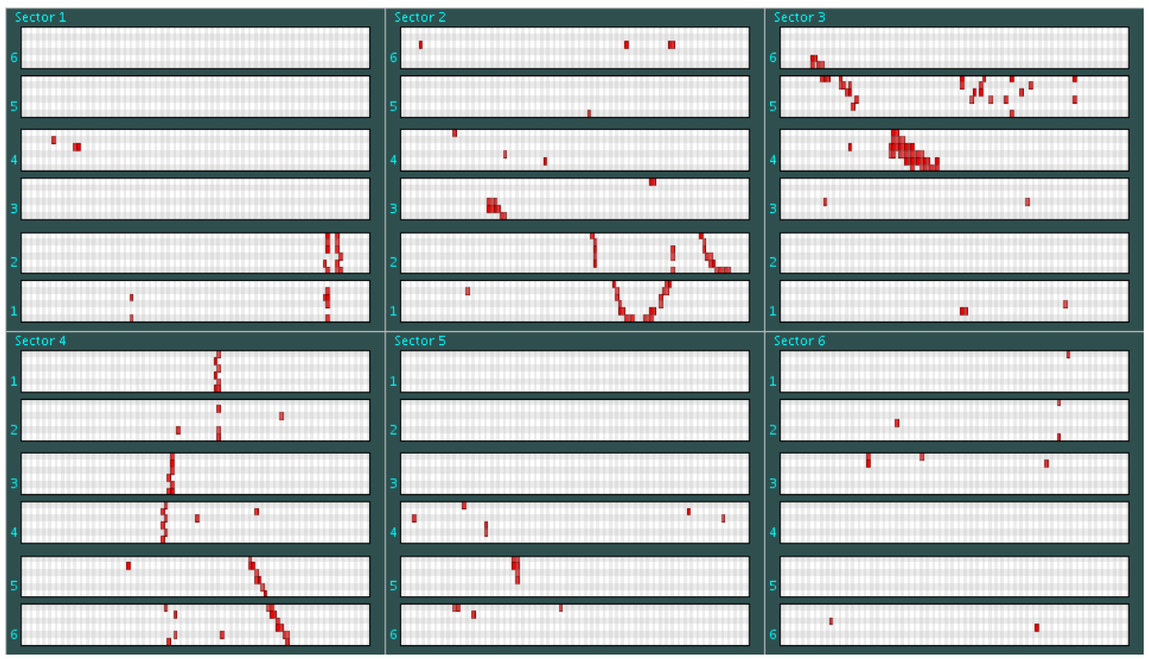
<option name=“MERGE_BGHITS” value=“bg.txt”/>

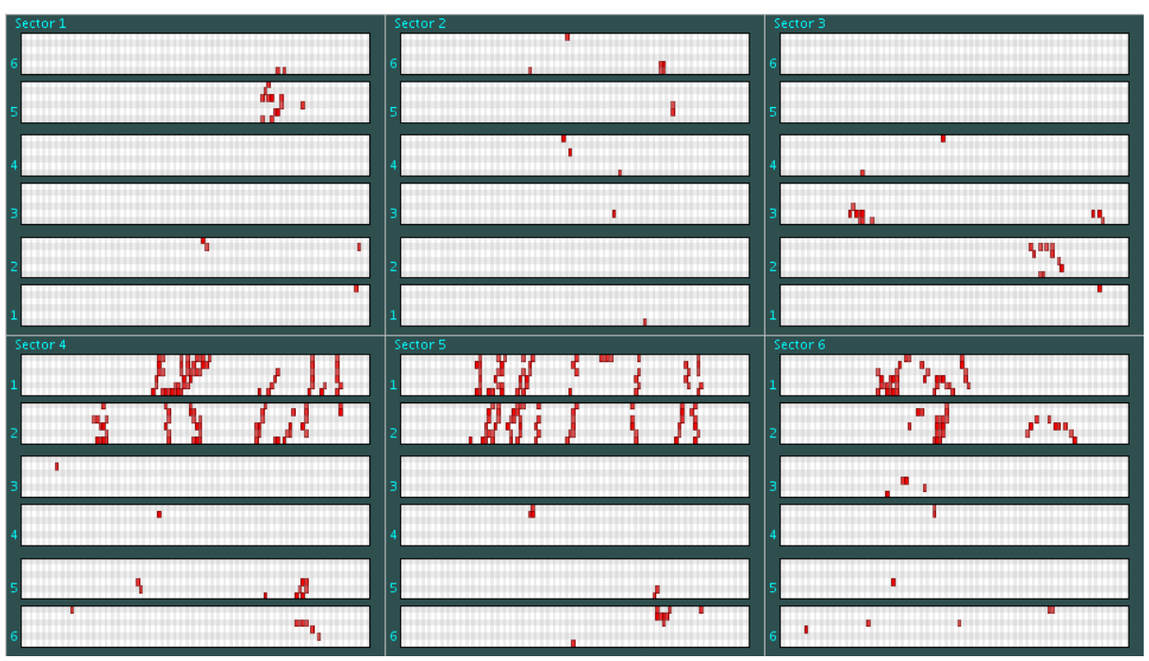
Note: also set FILTER_NULL_VARIABLES to 1 to save memory

Background Merging

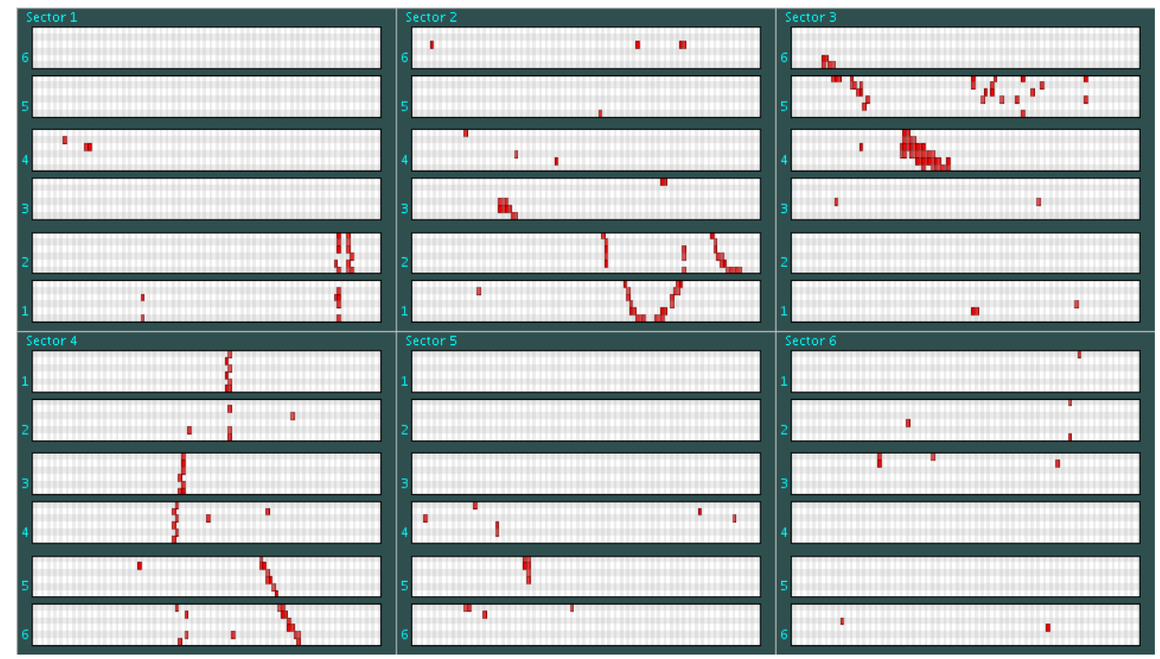
CLAS12 Note 2018-002

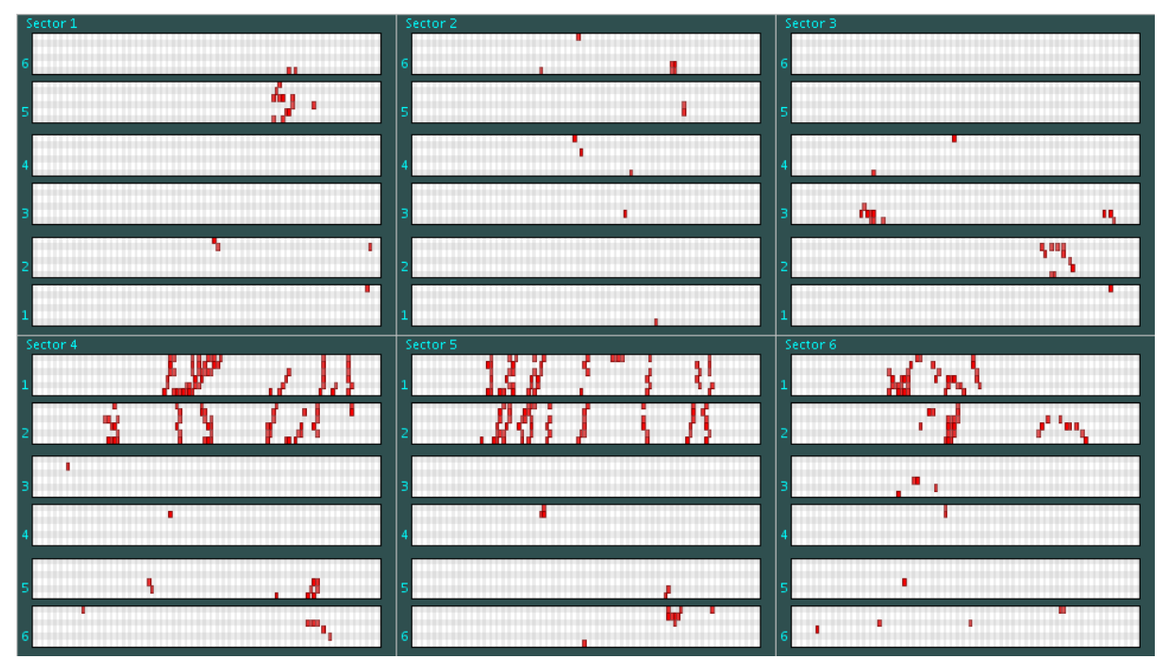
Data





GEMC





Background Merging

CLAS12 Note 2018-002

$10^{37}cm^{-2}s^{-1}$?

Simulation: run $10^{35}cm^{-2}s^{-1}$ and group 100 events into 1.

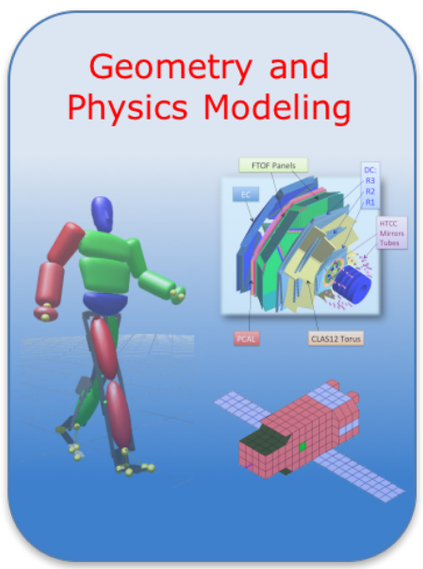
Data: No problem, just use random/pulse trigger

GEMC 3.X

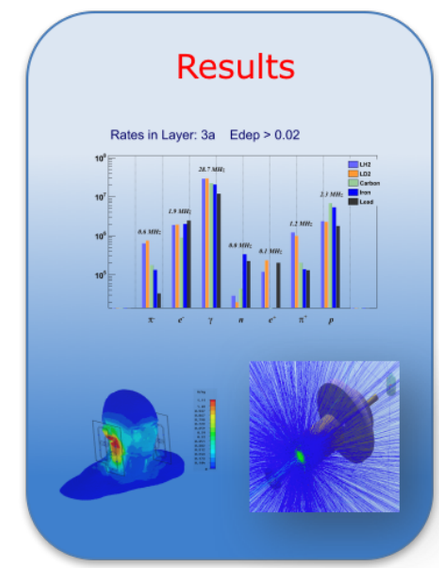
Complete rewrite. C++11 (14). G4 Multithreading transparent to users.

Improved API for digitization, “pulse” output, calibration constants mechanism.

New generator mechanism. Input file distributed to threads.



Hit collection from threads, output transparent to users.



Improved API for geometry. Add TGEO factory.

Output plugins include text, json, cvs, root.

Digitization is now a plugin: DLLs loaded at run time.

GEMC 3.X

- Option library ✅
- Match detector types to geant4 ✅
- Splash Screen library ✅
- Run Action ✅
- GEMC volumes definitions and factories ✅
- MT G4Cout redirections ✅
- Geant4 volumes factories:✅
- Touchable library ✅
- Constants mechanism ✅
- Digitization plugins ✅
- GUI Refurbish
- Event generation library / factories / plugin
- GUI Generator
- Output factories / plugins
- ROOT Output ✅
- Excel Output
- Replicas and Divisions
- Multihit TDC
- Read Gzipped field maps
- API to sqlite / mysql
- proMC support

detectors/clas12/ctof/plugin/hitDigitization.cc

```
GObservables* gdata = new GObservables();

double dvar = 2.22;

gdata->addObservable(dvar,        // variable value
                     “myName",     // variable name
                          "m",     // variable units
                     "double");   // save to disk as
```

(no more external definitions in “banks.pl”)

detectors/clas12/ctof/plugin/<u>loadConstants.cc</u>

```
bool ctofPlugin::loadConstants(int runno, string variation){

Constant1 = 2.198;

if(runno == 11)
Constant1 = 11.198;
if(runno == 12)
Constant1 = 12.198;

Constant2[0] = 1;

Constant3.push_back(3.0);
Constant3.push_back(4.0);
Constant4 = "hello";

return true;}
```

Doubles

Arrays

Vectors

Strings

Summary

GEMC 2.7:

- Add physical volume constructor - active rotations
- dipole map with reflection symmetry
- rotate fields
- luminosity spread of particle in time
- 3d field map

GEMC 3:

- Finalize “port” scripts and documentation so users can start ALPHA test if interested (30% done)
- Fields
- Generators
- GUI refurbish

Anticipated alpha release on June 2018.
Beta release on Sept 2018.