Run-Dependent CLAS12 Simulations

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**Abstract**

This document describes the changes done in GEMC to run simulations that account for changes in detector geometry, resolutions and efficiency using real run numbers instead of variations in the CCDB and SQLITE databases.

**Overview**

Current GEMC simulations use a fixed run number (11) to set geometry and run-group dependent conditions (e.g. list of malfunctioning elements), reading CCDB tables from different variations.

This approach becomes impractical due to the multiplication of CCDB variations, gcards, and yamls necessary as the number of experiments increases. Furthermore, the constants used in the simulations are different than the real data calibration constants used in reconstruction; ideally, we want the simulated data to be indistinguishable from real data by the reconstruction software.

Finally, it is impractical for implementing run-by-run changes such as temporarily dead elements.

**Run Number, Variations in Digitization Routines**

The CCDB calibration constants and geometry (in case of the COATJAVA geometry service) used in the simulations are loaded in GEMC by using the configuration flags:

* RUNNO: sets the CCDB run number
* DIGITIZATION\_VARIATION: sets the CCDB variation
* DIGITIZATION\_TIMESTAMP: selects a specific time snapshot of CCDB

For CLAS12 we have been using RUNNO=11 and variations corresponding to the real data variations, with a “\_mc” added in the string, for example: “rgc\_summer2022\_mc”. Some experiments shared the same “\_mc” variation strings, which can be confusing.

The reconstruction of simulated events uses similar strings for its configuration YAML files, and the right strings combination to use in simulation / reconstruction is maintained by keeping up to date the various repositories involved. This is a considerable overhead that can lead to oversights.

Using real run number solves any ambiguity: the simulation and reconstruction use the same calibration constants. Furthermore, it removes the need of using variations: both simulation and reconstruction can use ‘default’, provided all run groups keeps it up to date.

This approach has been solved in GEMC with the use of the SQLITE database for geometry. The run number was already used in the digitization routines.

**From TEXT to SQLITE Geometry Database**

The GEMC TEXT database uses strings in the filenames to distinguish variations in geometry and materials between different configurations. For examples:

* ec\_\_geometry\_default.txt
* ec\_\_geometry\_rga\_fall2018.txt
* ec\_\_materials\_default.txt
* ec\_\_materials\_rga\_fall2018.txt

Some systems use run numbers to get the parameters from the geometry databases using groovy to get it from the coatjava geometry service. For example:

factory.groovy --variation $variation --runnumber $runNumber

where the run number is set to 11 for the TEXT database.

The geometry is loaded into GEMC using the steering configuration files (GCARDS), for example:

<detector name="experiments/clas12/ec/ec" factory="TEXT" variation="rga\_fall2018"/>

Notice the run number is not specified in the TEXT database, and the run number information used in the geometry service is lost in the DB, only kept by the files in the perl files generating the geometry.

The TEXT geometry database is distributed using github tags of the clas12Tags repository, that contain the various text files, as shown in Figure 1.

The SQLITE mechanism replaces this approach to use a run number-based geometry and calibration constants. The corresponding GCARD entry for the SQLITE database is:

<detector name="experiments/clas12/ec/ec" factory="SQLITE"/>

Text

Description automatically generated

*Figure 1: the TEXT database files structure in the clas12Tags repository for the Band and Beamline systems.*

**API Changes:** **the SQLITE database for geometry**

Both the C++ source code and the PERL api have been updated to use an SQLITE database.

In the source code, new SQLITE factories have been added for geometry, materials, CAD import and mirror properties definitions.

**Detectors Summary**

**Summary**

**Conclusions**

Both the rates and the radiation damage benefit from 51 microns of tungsten shield around the CLAS12 scattering chambers. There is no benefit in additional thicknesses. The rates have been compared with physics run data at several beam currents. There is a good agreement between the real and the simulated data.

**References**

[1] *M. Ungaro*, clas12 simulation software / geometry tags: https://github.com/gemc/clas12Tags.

**Appendix A: Run ranges for CLAS12 experiments**

**See Calcom Link**

**Appendix B: System by System comparison**

The CLAS12 detectors API is kept in the repository gemc/detectors in subdirectories of “clas12”.

In each system a README.md file has instructions on how to run the comparison in two ways:

1. comparing TEXT and SQLITE databases, line by line and entry by entry. Result is satisfactory only if there are no differences.
2. comparing running GEMC with TEXT DB vs SQLITE DB using the same seed. Result is satisfactory only if the outputs are identical.

Note: the first CLAS12 Good Run was 3029. Historically we have been using the **rga\_fall2018** variation that start with Run 4763 in many systems as the default for many experiments. For those, we use extend **rga\_fall2018** back to Run 3029 to apply **rga\_fall2018** also to **rga\_spring2018**.

**EC:**

The first CLAS12 Run was 3029. Historically we have been using the 'rga\_fall2018' variation that start with Run 4763. Here we use Run 3029 to apply rga\_fall2018 also to rga\_spring2018.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variation** | **CCDB/SQL Run** | **Geometry** | **Output** |
| default | 11 | ✅ | ✅ |
| rga\_fall2018 | 3029 | ✅ | ✅ |

**PCAL:**

The first CLAS12 Run was 3029. Historically we have been using the 'rga\_fall2018' variation that start with Run 4763. Here we use Run 3029 to apply rga\_fall2018 also to rga\_spring2018.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variation** | **CCDB/SQL Run** | **Geometry** | **Output** |
| default | 11 | ✅ | ✅ |
| rga\_fall2018 | 3029 | ✅ | ✅ |

**DC:**

The first CLAS12 Run was 3029. However, we never changed anything in the DC configuration,

so, we use Run 11 for all runs.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variation** | **CCDB/SQL Run** | **Geometry** | **Output** |
| default | 11 | ✅ | ✅ |

**FTOF:**

The first CLAS12 Run was 3029. Historically we have been using the 'rga\_fall2018' variation that start with Run 4763. Here we use Run 3029 to apply rga\_fall2018 also to rga\_spring2018.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variation** | **CCDB/SQL Run** | **Geometry** | **Output** |
| default | 11 | ✅ | ✅ |
| rga\_fall2018 | 3029 | ✅ | ✅ |

**HTCC:**

The first CLAS12 Run was 3029. Historically we have been using the 'rga\_fall2018' variation that start with Run 4763. Here we use Run 3029 to apply rga\_fall2018 also to rga\_spring2018.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variation** | **CCDB/SQL Run** | **Geometry** | **Output** |
| original | 11 | ✅ | ✅ |
| rga\_spring2018 | 3029 | ✅ | ✅ |
| rga\_fall2018 | 4763 | ✅ | ✅ |