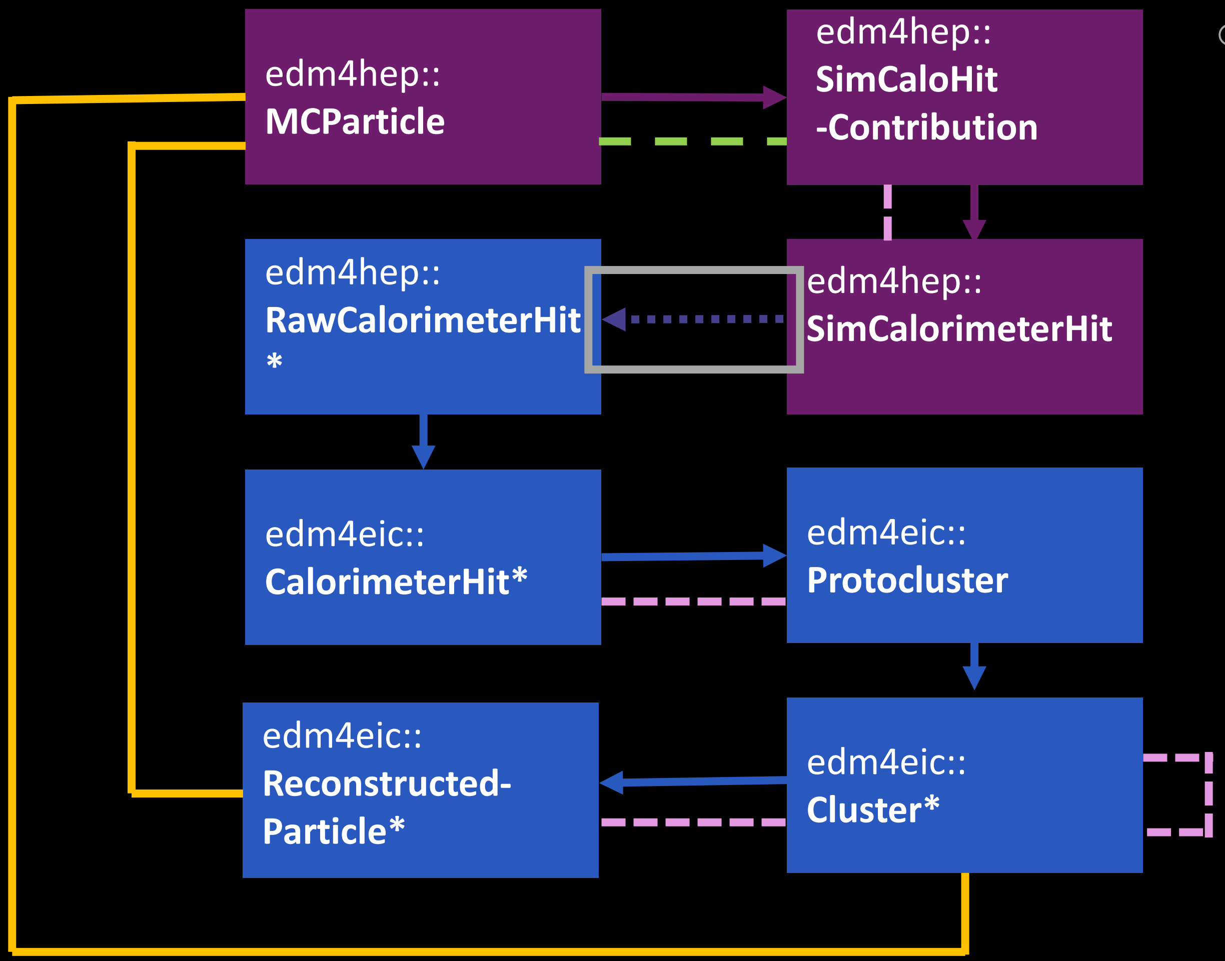
HGCROC Emulation Notes | where would it go?



- ○ **Grey Box:** where current digitization routine is located in calo workflow
  - ☞ This is what we want to expand and refine!

Legend:

◀···· = Digitization

━━ = Assocation

▬ ▬ = One-to-one relation

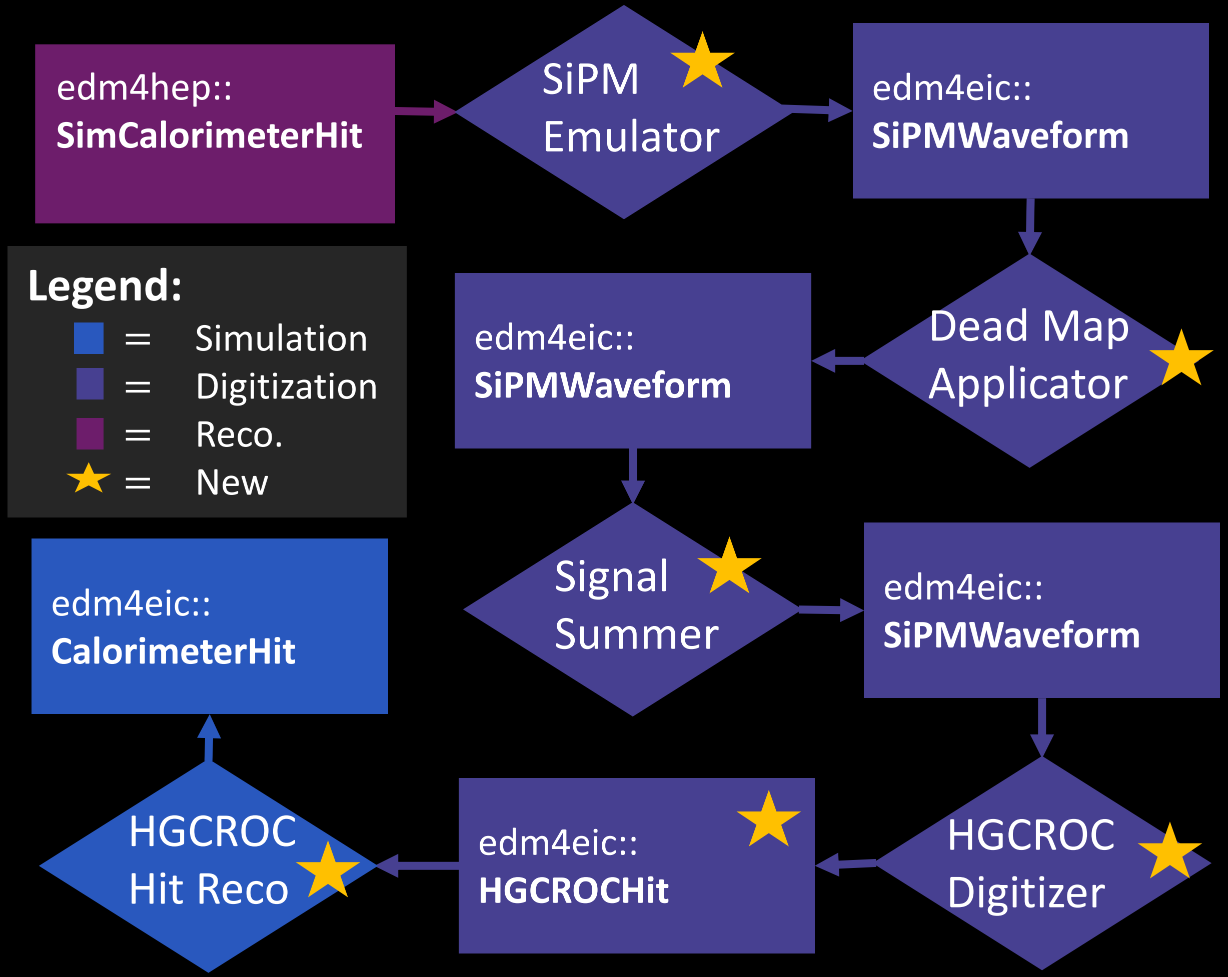
▪▬▬ = One-to-many relation

🟪 = DD4hep

🟦 = EICrecon

* Saved to EICrecon output by default

HGCROC Emulation Notes | proposed algorithm flow



edm4hep:: **SimCalorimeterHit** → SiPM Emulator ★ → edm4eic:: **SiPMWaveform** → Dead Map Applicator ★ → edm4eic:: **SiPMWaveform** → Signal Summer ★ → edm4eic:: **SiPMWaveform** → HGCROC Digitizer ★ → edm4eic:: **HGCROCHit** ★ → HGCROC Hit Reco ★ → edm4eic:: **CalorimeterHit**

Legend:

🟦 = Simulation

🟪 = Digitization

🟪 = Reco.

★ = New

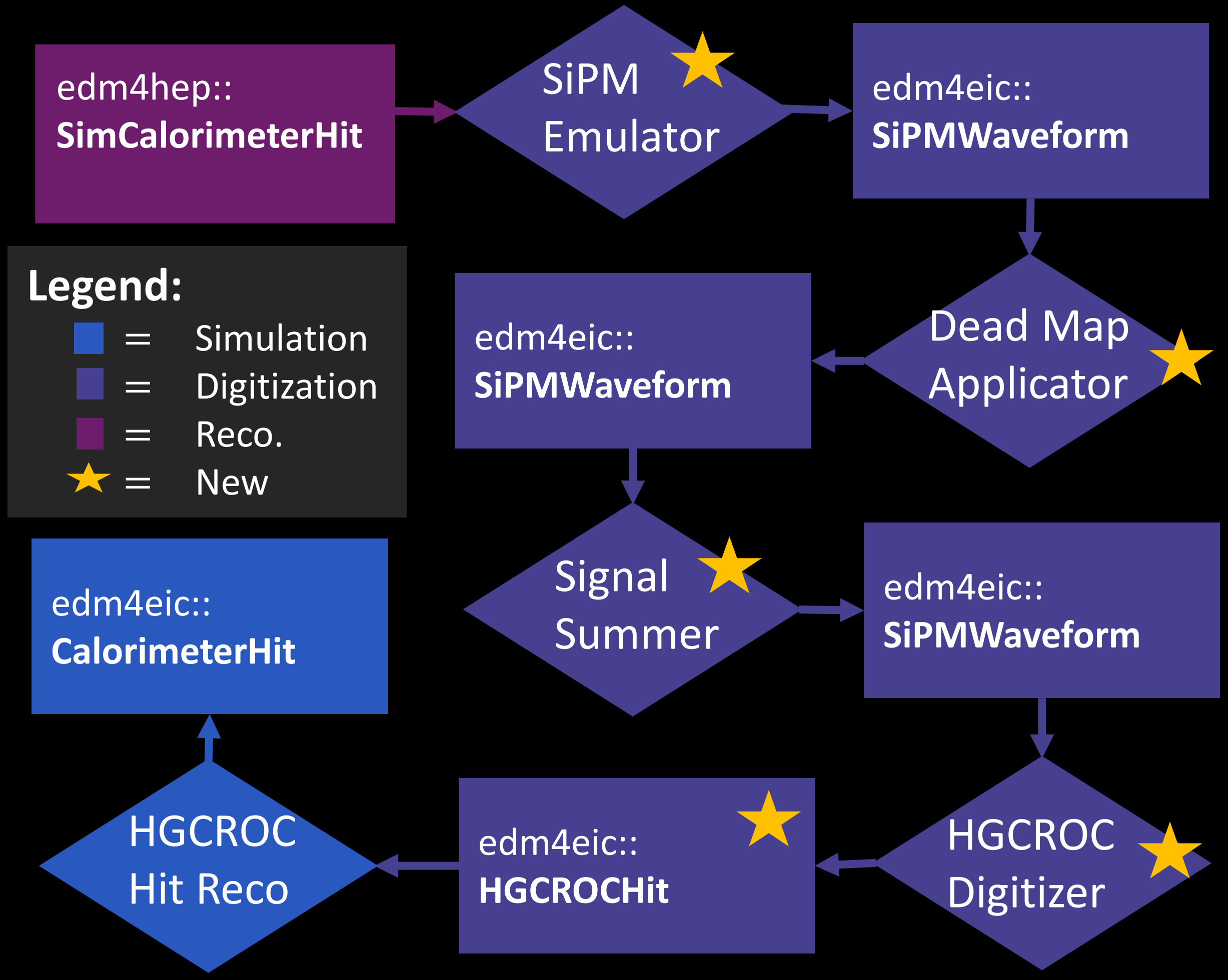
Algorithm: SiPM Emulator

- Note that Dima started work towards this in PR #1064
  - ☞ Suggestion from Dima: maybe use SimSiPM?
- Generates waveform from input simulated “hit”
  - ☞ (i.e. total deposited energy in a cell)

Algorithm: Dead Map Applicator

- Does what it says: applies a dead map based on a LUT
  - ☞ Could also be used to inject noise, apply uneven gains, etc.

HGCROC Emulation Notes | proposed algorithm flow



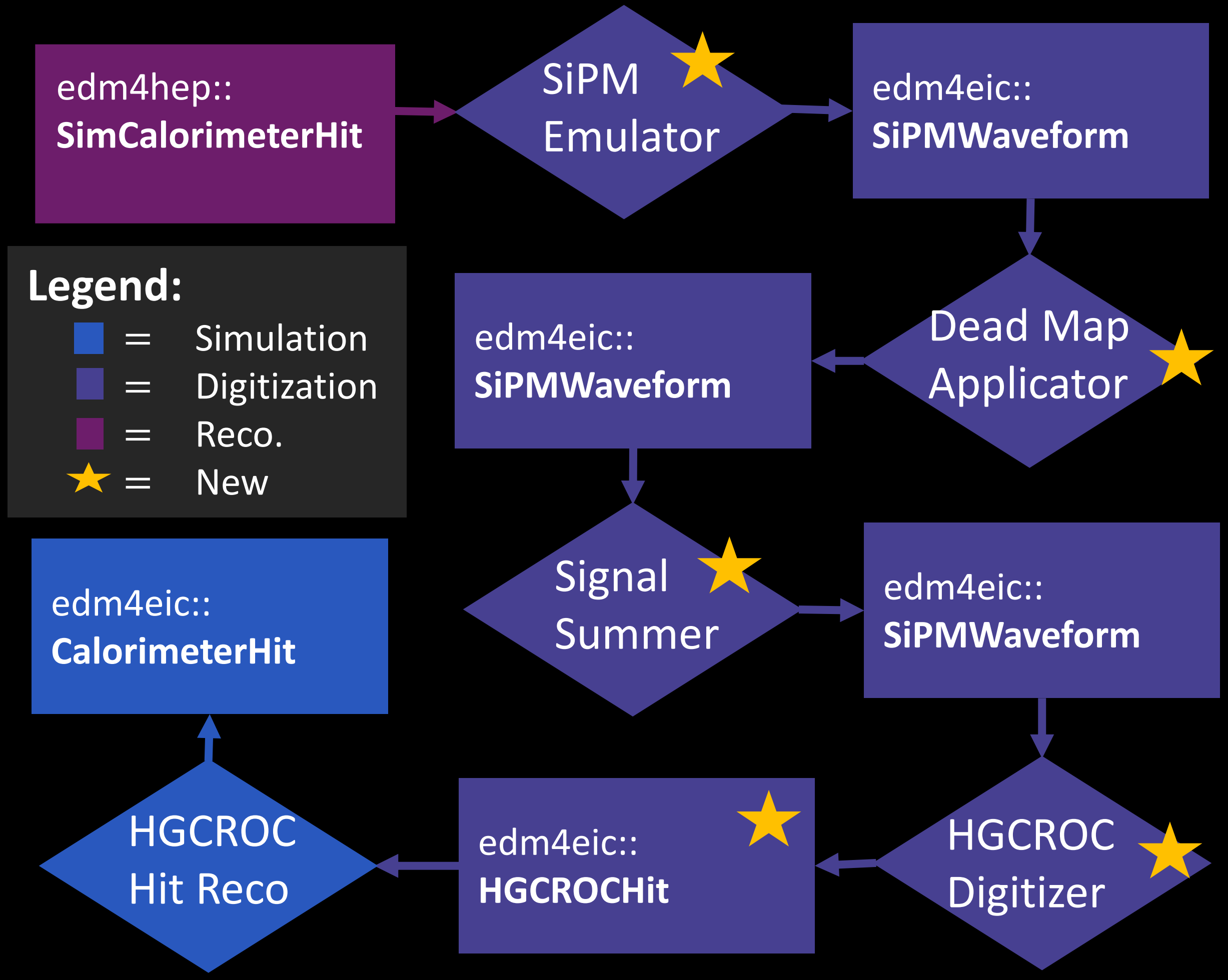
Algorithm: Signal Summer

- Here is where the LFHCAL would gang together channels into superchannels
  - Possibly likewise for the BIC
- Just sums up generated waveforms over a specified segmentation

Algorithm: HGCROC Digitizer

- Takes waveform, and turns it into an HGCROC hit
- At minimum, would get maximum from SiPM signal
  - Can be expanded later to include ToT and ToA info, etc.

HGCROC Emulation Notes | proposed algorithm flow



edm4hep:: **SimCalorimeterHit**

SiPM Emulator ★

edm4eic:: **SiPMWaveform**

Dead Map Applicator ★

edm4eic:: **SiPMWaveform**

Signal Summer ★

edm4eic:: **SiPMWaveform**

HGCROC Digitizer ★

edm4eic:: **HGCROCHit** ★

HGCROC Hit Reco

edm4eic:: **CalorimeterHit**

Legend:

- 🟦 = Simulation
- ■ = Digitization
- 🟪 = Reco.
- ★ = New

Algorithm: HGCROC Hit Reconstruction

- Takes HGCROC hits and convertes them into reconstructed hits (i.e. cells with definite energies)
- **Note:** summation currently handled here

Data Type: SiPM Waveform

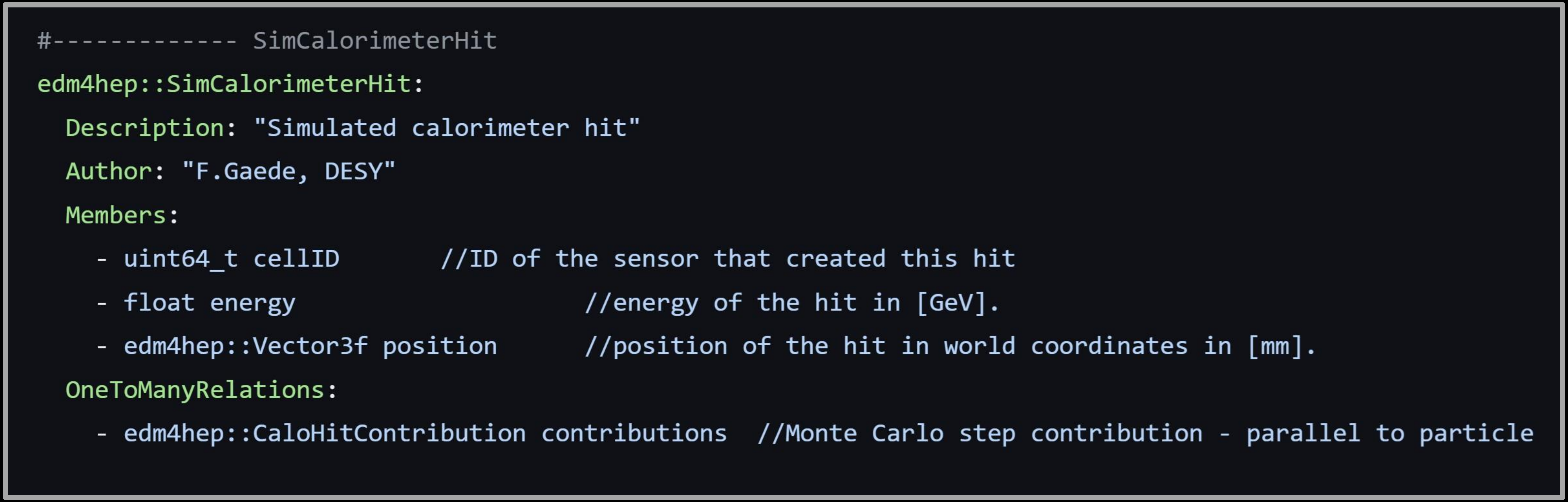
- Would be a new data type to represent a waveform

Data Type: HGCROC Hit

- Would be the HGCROC equivalent of a Raw Calorimeter Hit
- At minimum would have ToT, ToA, ADC, and Cell ID

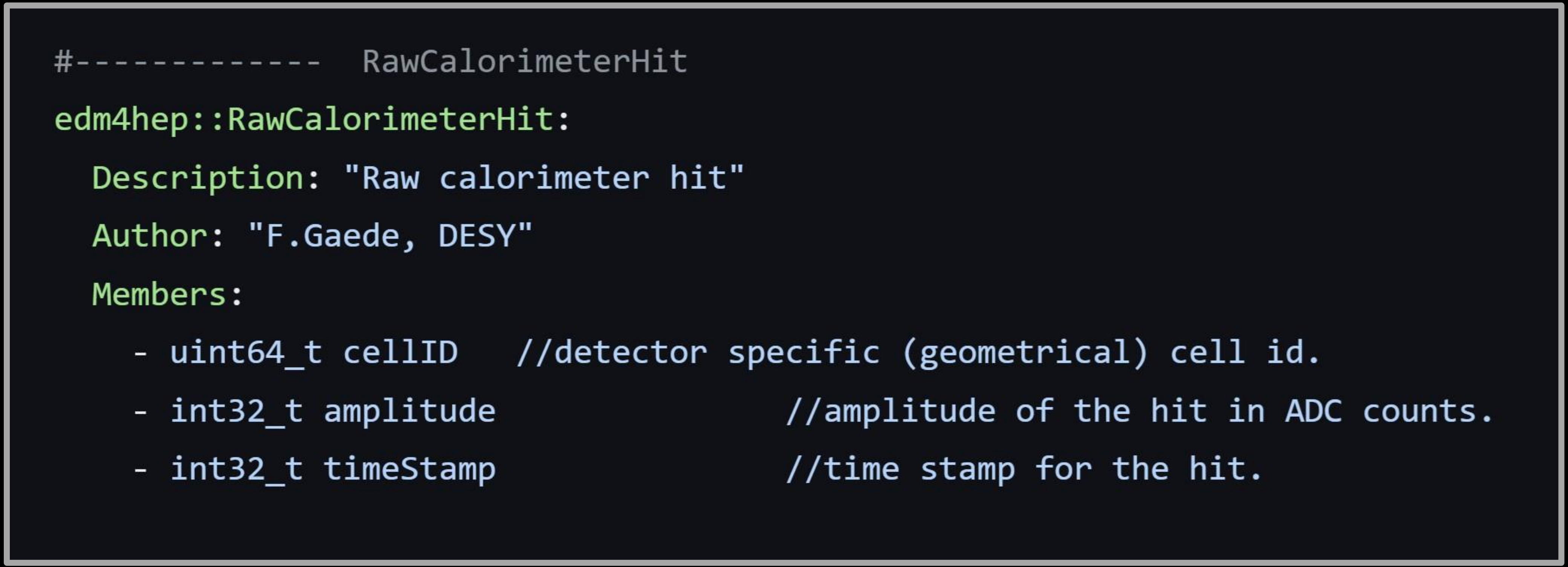
Backup

Backup | edm4hep::SimCalorimeterHit



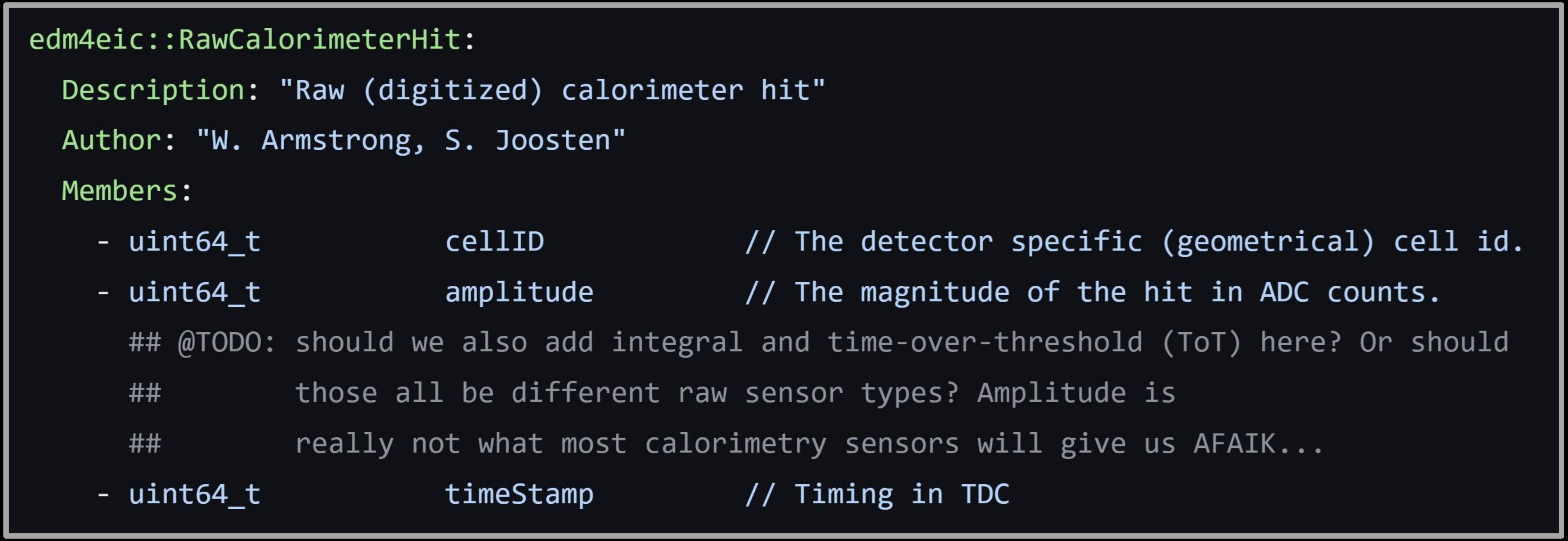
```
#------------- SimCalorimeterHit
edm4hep::SimCalorimeterHit:
  Description: "Simulated calorimeter hit"
  Author: "F.Gaede, DESY"
  Members:
    - uint64_t cellID       //ID of the sensor that created this hit
    - float energy                    //energy of the hit in [GeV].
    - edm4hep::Vector3f position      //position of the hit in world coordinates in [mm].
  OneToManyRelations:
    - edm4hep::CaloHitContribution contributions  //Monte Carlo step contribution - parallel to particle
```

Backup | edm4hep::RawCalorimeterHit



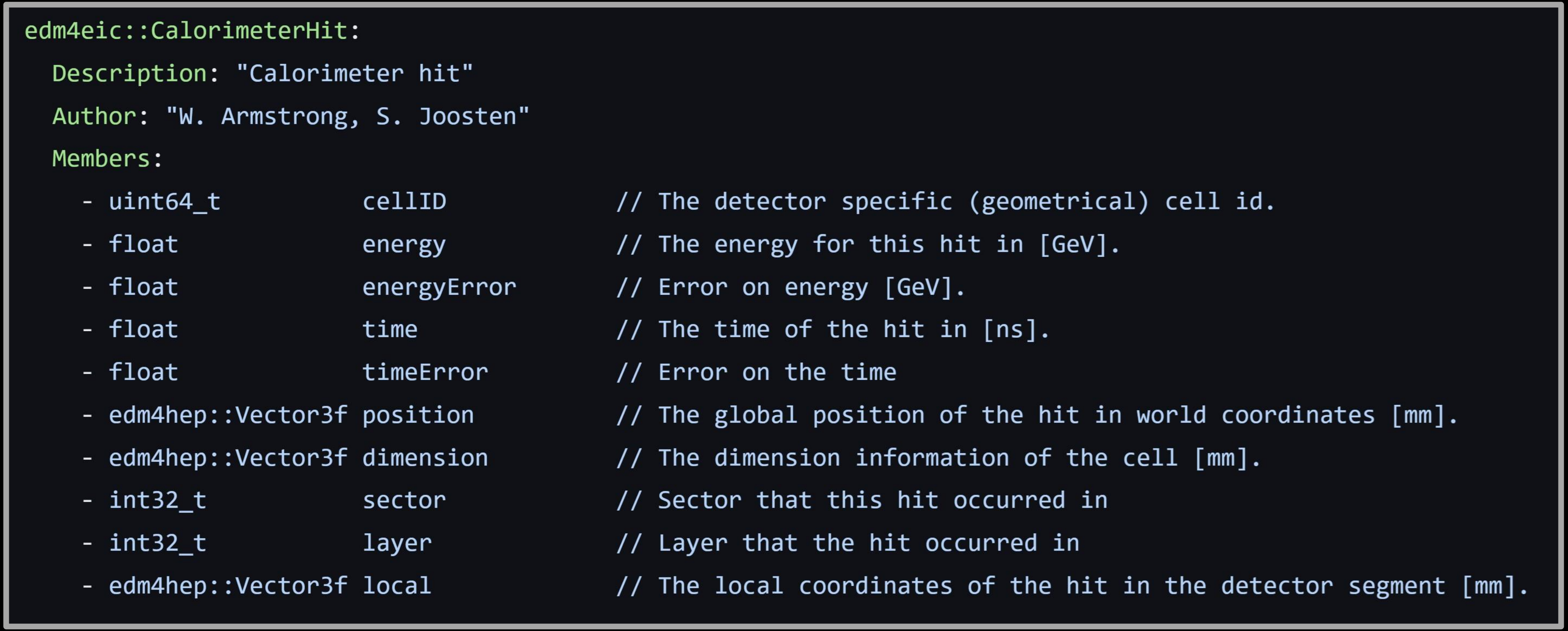
```
#-------------  RawCalorimeterHit
edm4hep::RawCalorimeterHit:
  Description: "Raw calorimeter hit"
  Author: "F.Gaede, DESY"
  Members:
    - uint64_t cellID   //detector specific (geometrical) cell id.
    - int32_t amplitude               //amplitude of the hit in ADC counts.
    - int32_t timeStamp               //time stamp for the hit.
```

Backup | edm4eic::RawCalorimeterHit



```
edm4eic::RawCalorimeterHit:
  Description: "Raw (digitized) calorimeter hit"
  Author: "W. Armstrong, S. Joosten"
  Members:
    - uint64_t           cellID            // The detector specific (geometrical) cell id.
    - uint64_t           amplitude         // The magnitude of the hit in ADC counts.
      ## @TODO: should we also add integral and time-over-threshold (ToT) here? Or should
      ##        those all be different raw sensor types? Amplitude is
      ##        really not what most calorimetry sensors will give us AFAIK...
    - uint64_t           timeStamp         // Timing in TDC
```

Backup | edm4eic::CalorimeterHit



```
edm4eic::CalorimeterHit:
  Description: "Calorimeter hit"
  Author: "W. Armstrong, S. Joosten"
  Members:
    - uint64_t          cellID            // The detector specific (geometrical) cell id.
    - float             energy            // The energy for this hit in [GeV].
    - float             energyError       // Error on energy [GeV].
    - float             time              // The time of the hit in [ns].
    - float             timeError         // Error on the time
    - edm4hep::Vector3f position          // The global position of the hit in world coordinates [mm].
    - edm4hep::Vector3f dimension         // The dimension information of the cell [mm].
    - int32_t           sector            // Sector that this hit occurred in
    - int32_t           layer             // Layer that the hit occurred in
    - edm4hep::Vector3f local             // The local coordinates of the hit in the detector segment [mm].
```