Interfacing FLUKA with LArSoft

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Intro: *MC-Truth might not be true*

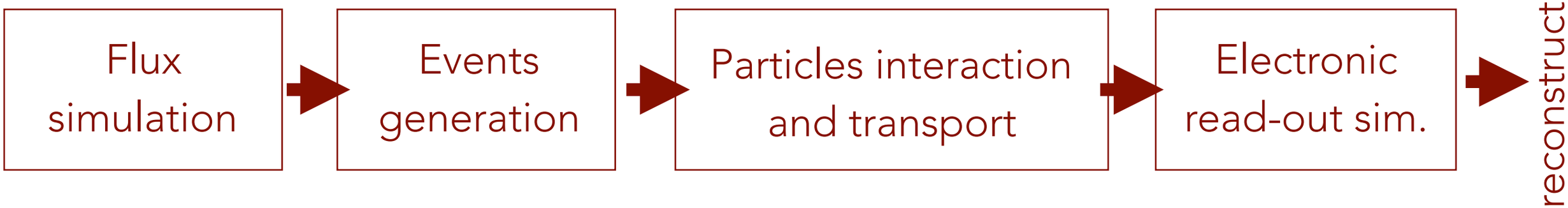
- Simulations packages like GEANT, FLUKA are generally very well performing but never perfect

- Current simulations for DUNE and protoDUNEs are based on GEANT. It might be that GEANT4 is the best understanding up to date, but we need to check its predictions

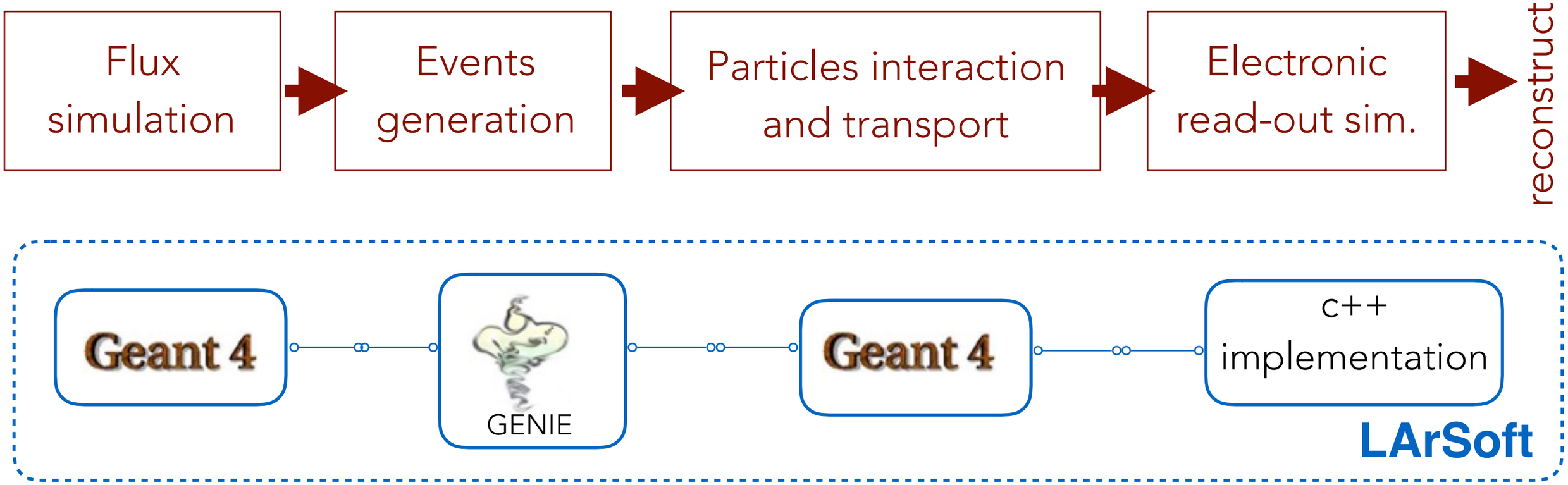
- For cross-section measurements we are used to compare data to different MC event generators
  - Important for the analysis to have the better predictions
  - Important for the MC because implementation can be adjusted following the developments of the theoretical models

- At this stage of the experiment, comparing different simulations at different points of the simulation chain can bring benefit to the future DUNE analyses and possibly to the other LAr-based experiments

The DUNE/pDUNEs simulation chain

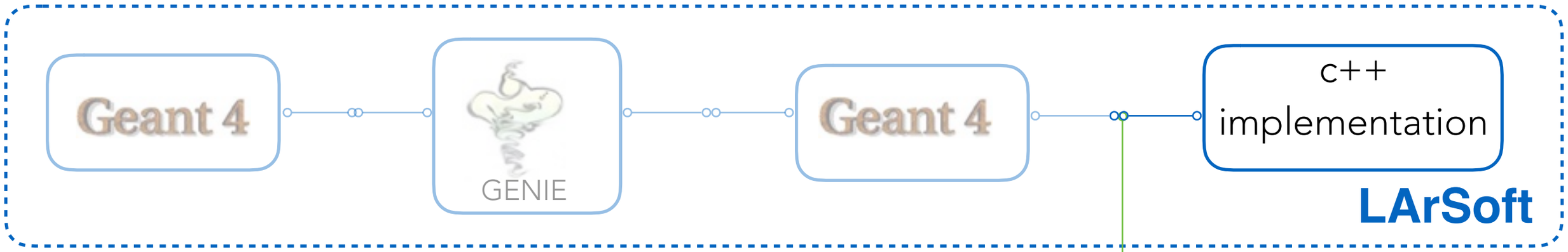


The DUNE/pDUNEs simulation chain



The DUNE/pDUNEs simulation chain

Flux simulation → Events generation → Particles interaction and transport → Electronic read-out sim. → reconstruction



the idea..

Electronic readout simulation and event reconstruction common to the two chains

Interfacing FLUKA to LArSoft

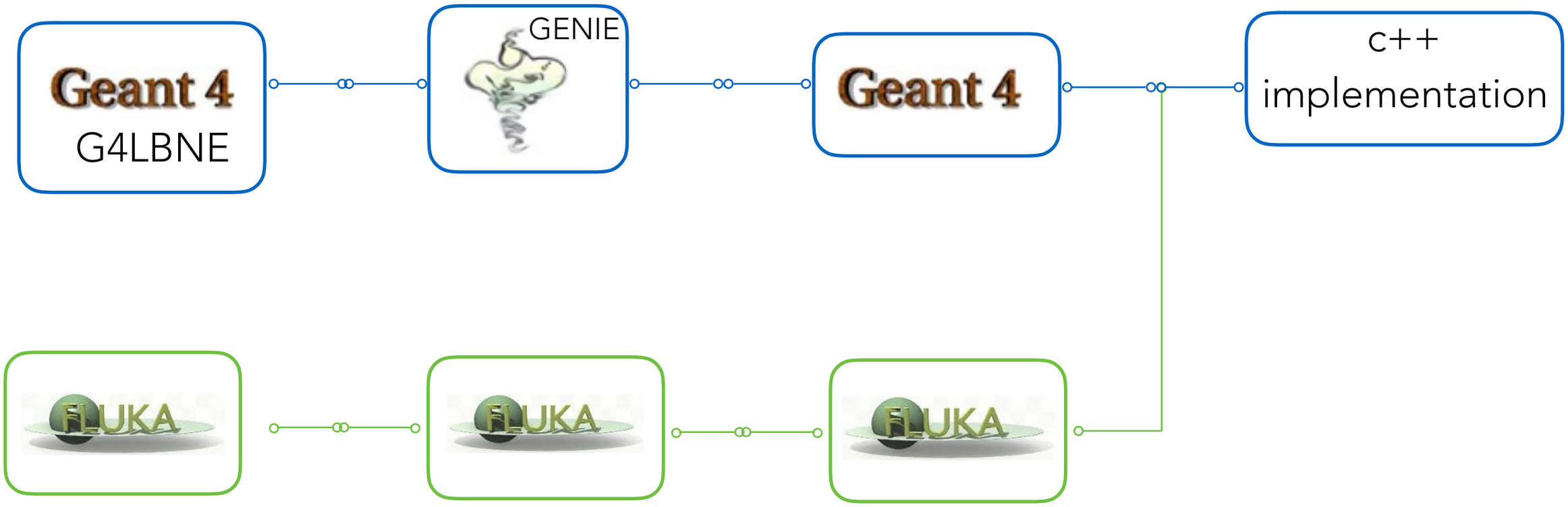
- Several steps are foreseen to interface FLUKA and be able to compare the results (*apples with apples*)

- 4 main steps have been identified (presented in the following slides)

- A road-map plan has been submitted the the LArSoft team to get some support

FLUKA Interface: work plan

Flux simulation → Events generation → Particles inter. and transport → Electronic read-out sim.



1st step : **Simulations up to the particles interactions and transport from FLUKA**

Status:

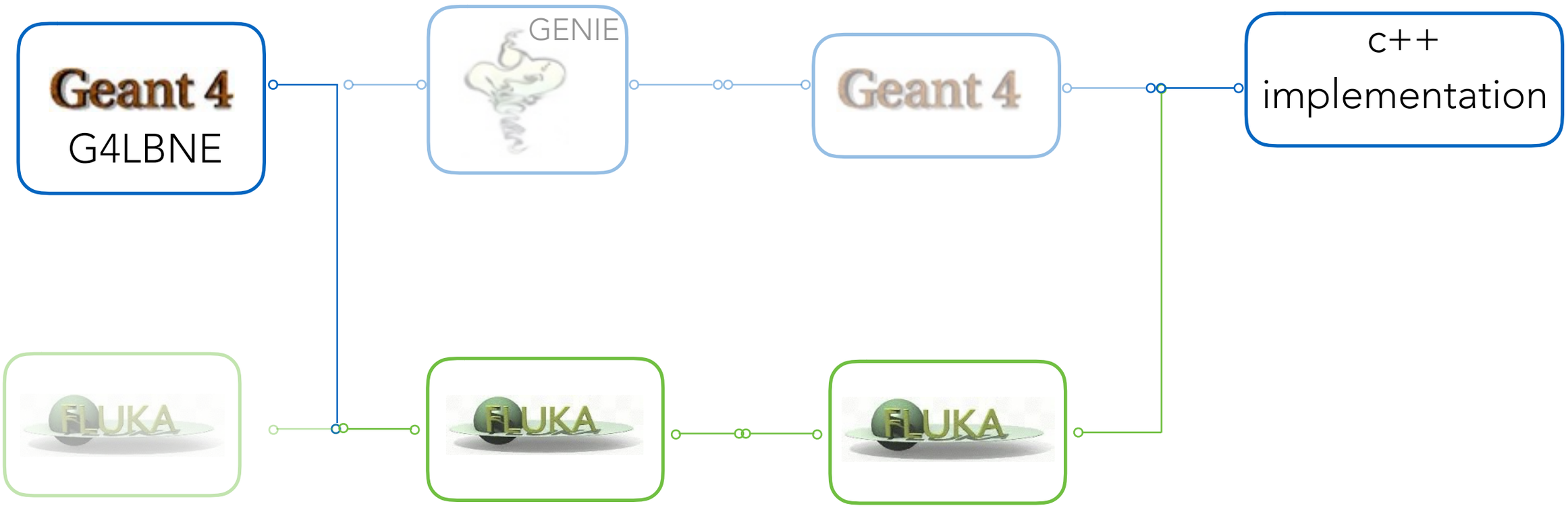
- Implementation almost complete (protoDUNE-sp)
- Connection between FLUKA and LArSoft to be implemented (**Interface**)

Output:

- First comparison with the default chain results but conclusions cannot be derived.

FLUKA Interface plan

Flux simulation → Events generation → Particles inter. and transport → Electronic read-out sim.



2nd step : **Consider the flux simulation from G4LBNE in the FLUKA chain**

Status:

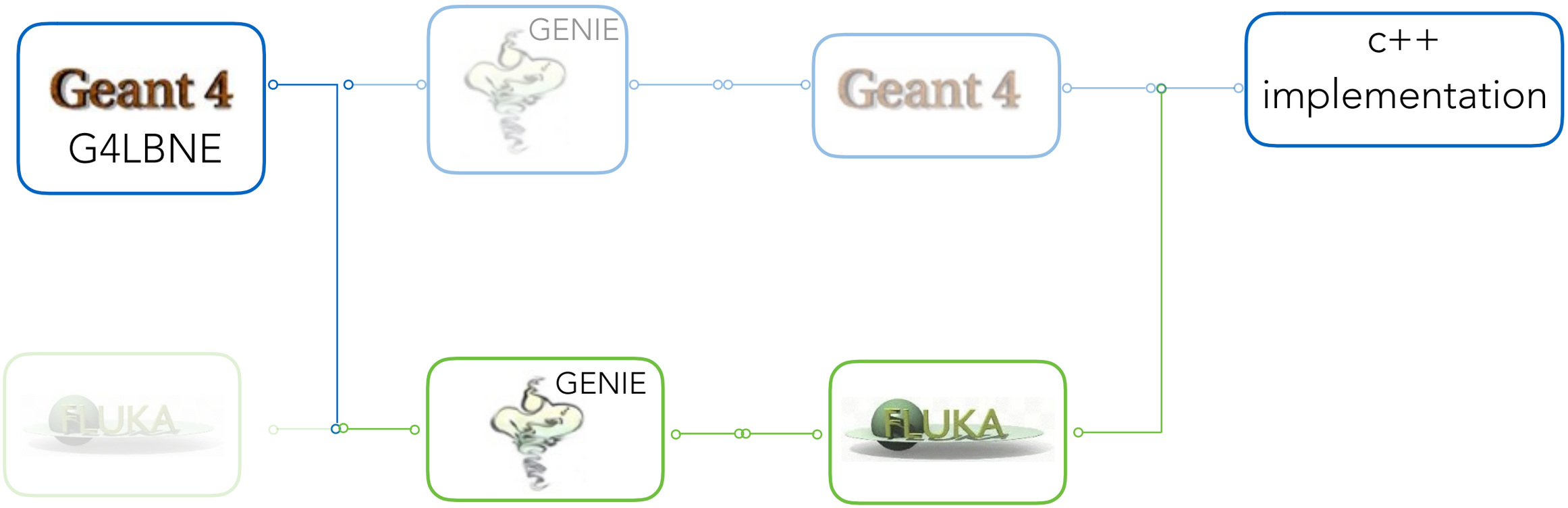
- FLUKA is already prepared for external flux input

Output:

- To be compared with the previous step ➞ impact of the flux simulation

FLUKA Interface plan

Flux simulation → Events generation → Particles inter. and transport → Electronic read-out sim.



3rd step : **Consider GENIE as neutrino event generator in the FLUKA chain**

Status:

- FLUKA is already prepared for using external event generator

Output:

- To be compared with the full default chain → impact of the particle interactions and transport ⊕ geometry

Concerning the geometry

- The FLUKA simulation has its own geometry implementation (see talk from Paola)
- protoDUNEs and FD geometries are pretty simple, but implementations might be different (e.g. screws, wires, …)
- To be able to compare the results of the simulations coming from FLUKA to the default chain, one has to consider the same geometry (4th step)

4th step : **Include the G4-based detector geometry in the FLUKA chain**

Status:

- On-going discussions about the strategy to be used (e.g. FLUGG, FLAIR, GeGeDe)
- Thoughts on (automatic) maintenance of two possible geometry

Output:

- To be compared with the full default chain → impact of the particle interactions and transport

Conclusions

- The simulation chain for protoDUNEs and DUNE is currently based on GEANT4. Predictions are good but validation and cross-checks are suitable

- A work to interface FLUKA with LArSoft is on-going

  - The electronic read-out simulation and particle reconstruction is kept common for the two simulation chains

  - From the comparison we can derive validations of the simulations at different stages (Flux, cosmics, particle interaction and transport)

- Rough estimation of the time-scale for the project ~8months