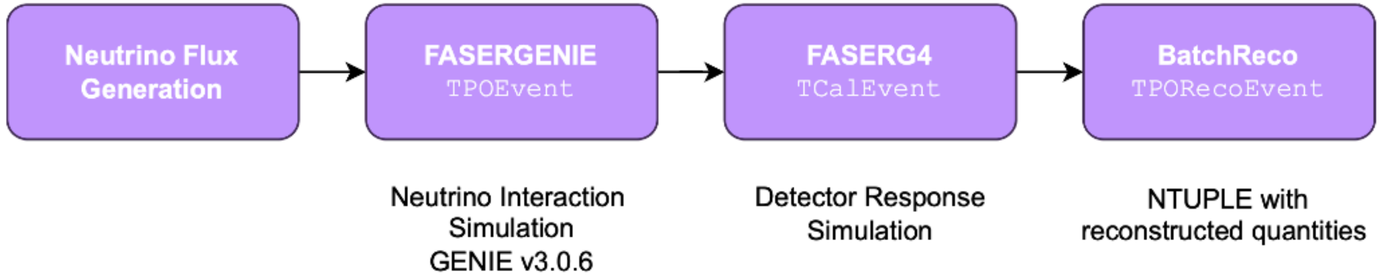
More physics

FASER physics

- **Light mesons (π, K)** → dominate the low-energy ν flux: **Precision SM tests:** Cross-sections of νe, νμ, ντ.
  - High-energy ν (TeV scale) come mainly from charm and beauty decays.
  - **Tau neutrinos (ντ)** are *almost entirely* from Ds → τντ → … chains.
  - Testing lepton universality (does ντ interact as predicted, same as νμ, νe?).
  - Study neutrino CC interactions with charm production ($\nu s \to lc$) (No charmed hadron has been observed in $\nu_e CC$ interactions)
  - **Long-Lived Particles (LLPs)** are hypothetical particles predicted by many extensions of the Standard Model. (Decay inside a detector like FASER → visible signatures (e.g. e^+e^-, $\mu^+\mu^-$, γγ).
- QCD uncertainties
  - Forward production of charm and beauty is **not well measured** by ATLAS/CMS (θ ≲ 1 mrad), because they don't cover the extreme forward region.
  - Models (PYTHIA, EPOS, SIBYLL, etc.) disagree significantly.
- By measuring neutrino rates and spectra - FASER indirectly constrains **how many charm/beauty hadrons were produced**.

Data Generation

Pipeline



- **Neutrino flux:** generated using the SIBYLL 2.3d hadronic interaction model
  - Neutrinos propagated and projected onto a transverse plane located at z= 480m downstream of the IP, (FASER experimental site)
- **FASERGENIE:** simulation of neutrino-nucleus interactions. Using the GENIE (Generates Events for Neutrino Interaction Experiments).
  - GENIE simulates interaction of neutrinos from the flux with the materials defined in the detector geometry. (includes (DIS), (QE) and (RES) interactions for both (CC) and (NC) processes.
- **FASERG4:** FASERCal response built on Geant4: FASERG4 reads primary particles from GENIE and propagates them through the detector - simulating ionization, scattering, Bremsstrahlung, pair production, hadronic interactions, and particle decays
- **Event Reconstruction**