

# Fast and full simulations in Geant4 for large-scale detector systems at the EIC with a plug and play modular approach

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- Requirements
  - ability to **reuse existing simulation works**
  - ease of **switching detector options** with comparable levels of detail
  - ease of switching between **detailed and coarse** detector descriptions
  - ease of **leveraging new and rapidly evolving**
    - technologies, e.g., AI/ML
    - computing hardware, e.g., heterogeneous architectures

- These requirements will be fulfilled by utilizing the “region” mechanism of Geant4.
  - Each detector component is represented as a region, where the followings are taken care of.
    - geometry description including different levels of detail,
    - physics options including fast simulation and unique physics model configurations,
    - and detector responses based on geometry and physics options
  - Regions should not interfere to each other.
    - Sanity checking tools provided.
  - We will collaborate with developers of existing simulators, i.e. *EicRoot*, *Eic-Smear*, *ESCalate* and *Fun4All*.
- We avoid unnecessary wrappers and external dependencies. We use native Geant4 functionalities as much as possible.
  - Initially we try to cope with external dependencies inheriting from existing simulators by encapsulating them into a region.

- The simulation application will be built on top of the newly coming Geant4 version 11.
  - Tasking (both PTL and TBB) mechanism is introduced.
    - Enabling heterogeneous hardware configuration
  - Current Geant4 v10.7 is an alpha version of Geant4 v11. Beta release of version 11 is scheduled in June.
- Data exchange format / tool for geometry, event data, detector parameters, etc.
  - We won't invent a new wheel. We will join the discussion of EIC SW.
- Concerning about physics models, we will start with building a common EIC physics list
  - With surveying test-beam results for its validation
    - Importing/integrating test-beam geometries if available
  - With developing options for
    - Deferent physics parameters per region
    - Fast simulation / event biasing per region