
# New Extended Hadronic Example :

# **ParticleFluence**

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# Motivation

- ATLAS has reported (recently) significant changes in particle fluence between Geant4 10.1 and 10.6
  - In different positions of their detector
  - For various particle types, and for “low-energy” (< 20 MeV) and “high-energy” (> 20 MeV)
  - Would like to know the sources of these changes
- Our Geant4 testing and validation suite monitors carefully the properties of hadronic showers, but not (yet) particle fluence
  - Hadronic showers are important for HEP analysis
  - Particle fluences are important for shielding and radiation damage studies
- We need to add a dedicated test for particle fluence
  - Regression testing – comparing Geant4 versions

# Particle Fluence

- It is convenient to compute the particle fluence in a “scoring volume” as follows: *average* ***sum of track lengths*** *in the scoring volume,* ***divided by the cubic volume*** *of such a scoring volume*
  - Unit: cm^-2 ; referred to a single primary projectile
- The idea is to shoot a primary projectile in a given set-up, and compute the particle fluence in a few, key positions
  - *e.g.* “downstream” and “upstream”, by introducing ad-hoc thin “scoring volumes” where to evaluate particle fluence
  - Computing an “overall” particle fluence, but also for some particle types, as well as for “low-energy” and “high-energy”
  - Results in form of a table of numbers, useful for regression testing
    - No experimental data; look for significant changes between Geant4 versions
  - Added also information on secondaries (multiplicity and kinetic energy)
    - To correlate changes in particle fluence with changes in particle production by physics models

# Set-ups

- 4 set-ups considered
  - **Layer*l*** : target cylinder of a single material
  - **Sphere*l*** : full solid target sphere of a single material
  - **ConcentricSpheres*l*** : one sphere and two external spherical shells
    - Proxy for Tracker, EM calorimeter, and HAD calorimeter
    - Single material in each sphere, some space (vacuum) between them
  - **Calo*l*** : simplified (cylindrical) hadronic calorimeter
- Materials and dimensions configurable via UI macro
  - Beam particles shot along the z-axis, from left to right for Layer & Calo, from the center of the sphere(s) for Sphere and ConcentricSpheres
- Scoring positions
  - *Downstream* , *Upstream* , *Side* : for Layer and Calo
  - *Forward* , *Backward* : for Sphere and ConcentricSpheres
    - For the ConcentricSpheres, separated scoring for each of the three spheres

# Particle Fluence per Particle-Type and Particle-Energy

- 10 particle-types
  - Any
  - Electron and positron
  - Gamma
  - Muons
  - Neutrinos and anti-neutrinos – of any flavor
  - Neutron and anti_neutron
  - Proton and anti_proton
  - Ions and anti_ions
  - Other mesons (kaons, *etc.*)
  - Other baryons (hyperons, *etc.*)
- 3 ranges in kinetic energy (for each particle type)
  - Any
  - Below 20 MeV
  - Above 20 MeV