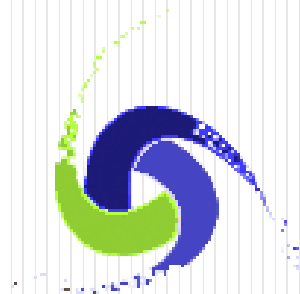# Developments for 2019:
EM physics

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for Geant4 Collaboration

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Outline

- Infrastructure and general support for EM physics
- Development of the processes of multiple and single scattering
- Further update of ionization processes
- Bremsstrahlung and gamma models
- Extended models of positron annihilation
- Low-energy EM models
- Optical photon and X-ray physics
- User proposed modifications

- (*) – manpower is not identified yet

Geant4 EM physics

Infrastructure and general support for EM physics

- perform regular execution and regression analysis using existing testing suites (1/2)
  - migration of testing suite from lxbatch to Condor (1)
  - introduction of detailed test of stepping for EM calorimeters triggered by ATLAS (1)
  - extension of validation of EM biasing options (1/2)
  - addition of CMS HGCAL test-beam into testing suite (2) (*)
- Code speed-up
  - extension of G4DynamicParticle with logarithm of energy in order to reduce number of calls to logarithm (1)
  - Evaluate on "global process" approach for gamma and electrons (1/2)
- introduction of gamma linear polarisation option to be applied to any EM physics configuration (1/2)
- addition of a new example with more realistic human phantoms for radiation protection and medical purposes (2)
- extension of dark matter particle interactions (1/2)
- study on effect of high energy muon scattering due to radiative processes (1/2) (*)

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Development of the processes of multiple and single scattering

- Goudsmit-Saunderson model
  - further tuning and optimisation of options for the for HEP applications (1)
  - new single scattering model for e+- based on ELSEPA (numerical Dirac-Fock PWA) (2)
- WVI and SS models
  - review implementation of Mott corrections (1)
  - evaluate performance with 2-nd order corrections enabled (2) (*)
- study on of the displacement beyond boundary algorithm (1/2) (*)

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Further update of ionization processes

- Review model for sampling fluctuations of e+-, look for the alternative model (1/2)

- Evaluate usage of ICRU90 stopping power data (1/2) involving GATE developers

- Evaluate new ion ionisation models for moderate and high energies (1)
  - Evaluate new ion energy fluctuations model (2)

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Bremsstrahlung and gamma models

- introduce bremsstrahlung on atomic electrons at high and moderate energies with triplet production (2)
- extension of the gamma conversion models:
  - relativistic model will be extended down in energy to cover the full energy range (1)
  - refinement of the 5D gamma conversion model and extend applicability range above 80 GeV (1/2)
- extension of gamma conversion to muon pair model down in energy to cover the full energy range (1)
  - Requested by gamma factory design group

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Extended models of positron annihilation

- deployment of new model of the three gamma annihilation (1)
- addition of tau pair production by positrons (2)
- extend energy limit for positron annihilation to hadrons (1/2) (*)

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Low-energy EM models

- Livermore and related models
  - new model for polarized pair production in nuclear field (2) (*)
  - improvement of pair production in the electron field (2) (*)
- Penelope models:
  - update and management of physics processes (2)
- Monash U. model:
  - complete the recalculation of atomic electron momentum PDFs and Compton profiles for elements $Z= 1$ to $Z= 100$ (2)
- Atomic de-excitation:
  - continue extension of shell ionisation cross section database for protons and alphas
- Continue testing and validation (2)

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Optical photon and X-ray physics

- improve Synchrotron radiation in quadrupole field (1/2)

- validation of the transition radiation model for ATLAS (1/2)

- extended and clean-up optical examples (1/2)

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Geant4-DNA models

- new and/or alternative cross section models for biological media (liquid water and related materials) [STD] (2)

- optimization & new chemistry models (2) (*)

- Update of existing and providing new DNA examples for physics, chemistry and DNA damage prediction (1/2)

Geant4 EM physics

User proposed modifications

- In GitHub several users proposed improvements to EM code
  - We appreciate user efforts and will consider all user proposals
  - Few technical fixes are already integrated and will be available in the patch to 10.5
- There are two pending proposals:
  - To change signature of EM process constructors
    - will be done in a way which will not change API for the minor release
  - to add different computation of the Density effect
    - Should be first discussed at EM meeting

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