New High Energy Models
Development & Validation Tool

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Outline

• New High Energy Models
  – Motivation & Prerequisites
  – Status of electron Bremsstrahlung
  – Recent developments in Pair production
• New Web-based Interface to Verification
  – Structure & Idea
• Selected Verification results
  – Live Presentation
• Summary/Outlook
New High energy models

• Motivation
  – high energy scale asked for by LHC experiments
  – improve precision by proper incorporation of material effects (LPM, density)
  – increase range of applicability to astro particle physics simulations
  – simplification due to high-energy approx. (possibly speed up)

• Starting with:
  – High-energy Bremsstrahlung (available since 9.2)
  – High-energy Pair-production (1st version in 9.3beta)
Reminder: LPM in bremsstrahlung

- **Basis:** simple analytic formula

\[
\frac{d\sigma}{dk} = \frac{4\alpha r_e^2}{3k} \left[ \xi(s) \left\{ y^2 G(s) + 2[1 + (1 - y)^2] \phi(s) \right\} [Z^2 (F_{el} - f) + Z F_{inel}] + (1 - y) \frac{Z}{3} \right]
\]

- **Includes:**
  - corrected **Density-Effect** constant
  - improved **LPM description**
  - checked against experimental data (valid \( E > 1 \) GeV)

- **Further validation**
  - Seltzer & Berger
  - EEDL (employing Python interface by Katsuya) (see live demo)
Developments in Pairproduction

- **Status:**
  - incorporated LPM using simple analytic formula, in analogy to Bremsstrahlung

\[
\frac{d\sigma}{dk} = \frac{4\alpha Z^2 r_e^2}{3k} \left\{ \begin{array}{c} G(s) + 2\phi(s) \\ \Phi_1(\delta) \end{array} \right\} \left\{ \begin{array}{c} (y^2 + (1 - y)^2) \frac{\Phi_1(\delta)}{4} - \log Z - 3f \\ y(1 - y) \frac{\Phi_2(\delta)}{4} - \log Z - 3f \end{array} \right\}
\]

- **Simplifications:**
  - no dEdx
  - LPM only at very high energies

- **Validation:**
  - only limited validation data
  - comparison with NIST (see live demo)
New Web interface to verification results

• Vladimir’s Validation repository:
  http://cern.ch/vnivanch/verification/verification/electromagnetic/
  – Link available via Geant4 web site
  – hosts a large collection of results
  – includes results for different (intermediate) Geant4 versions
  – data available as pictures (png, gif, etc.) and (partially) results (ascii, root)
  – But: Difficult to navigate and compare

• Idea: Provide Web-interface
  – include Bremsstrahlung and Pair production validation and verification
Demonstration

- “QuickView”
  - brems.slacE146, test37, test41, ...
  - automatic parsing for pictures (gif, png, jpg)
“Customized View”

- brems.compare, brems.lpm, pair.nist
- naming convention for pictures
- simple XML config file
“Interactive View”

- brems.eedl, atlasbar, cmscal, lhcb
- arbitrary comparison using root-input data
Web interface - Verification

• “Quick View”
  – provides web interface for a more simple access to existing pictures
  – easy customizable via XML file
  – uses PHP and JavaScript

• “Interactive View”
  – arbitrary combination of existing results to create new comparison plots
  – uses PHP, JavaScript and PyROOT

• Proof-of-Concept version exists now........ http://www.ifh.de/ILC/geant4/
Summary/Outlook

• New high-energy models perform good (partially even at moderate energies)
  – new Pair production includes LPM effect
  – smoother than existing parametrisation
  – very good agreement with NIST for intermediate Z
  – good agreement above 1 GeV

• Web interface to EM verification exists
  – proof-of-concept version
  – extension to include “quality measures” feasible but priorities should be discussed.