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)

- Basis: simple analytic formula

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

- 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

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

  $$\left. + G(s)\left\{y(1-y)\frac{\Phi_2(\delta)}{4} - \log Z - 3f\right\}\right]$$

- ### 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:

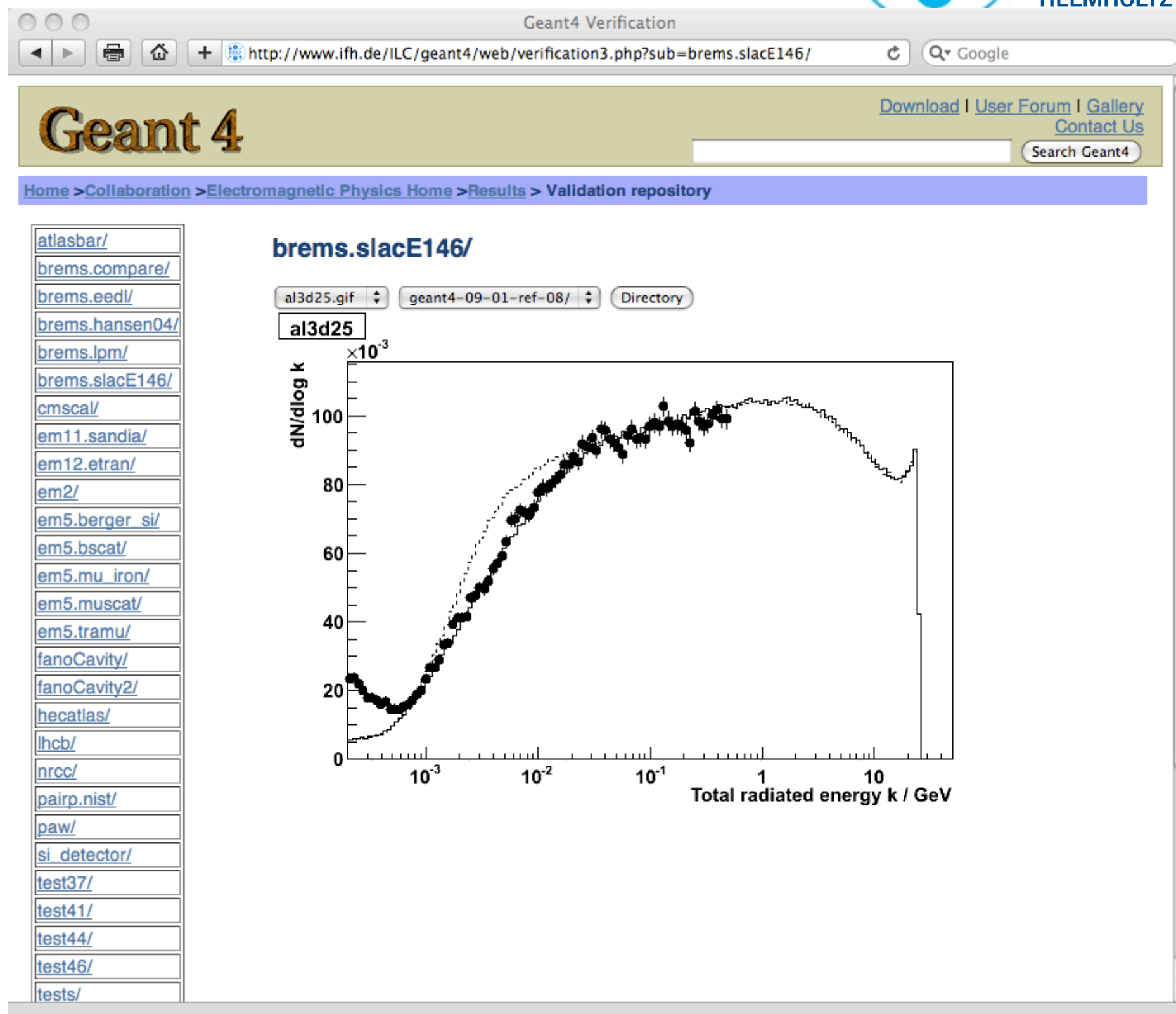 http://cern.ch/vnivanch/verification/verification/electromagnetic/

  – 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

Parent Directory
atlasbar/
brems.eedl/
cmscal/
em2/
em5.berger_si/
em5.bscat/
em5.mu_iron/
em5.muscat/
em5.tramu/
em11.sandia/
em12.etran/
fanoCavity/
fanoCavity2/
hecatlas/
lhcb/
lpm/

Demonstration

- "QuickView"
  - brems.slacE146, test37, test41, ...
  - automatic parsing for pictures (gif, png, jpg)

Demonstration

"Customized View"

– brems.compare, brems.lpm, pair.nist

– naming convention for pictures

– simple XML config file

Demonstration
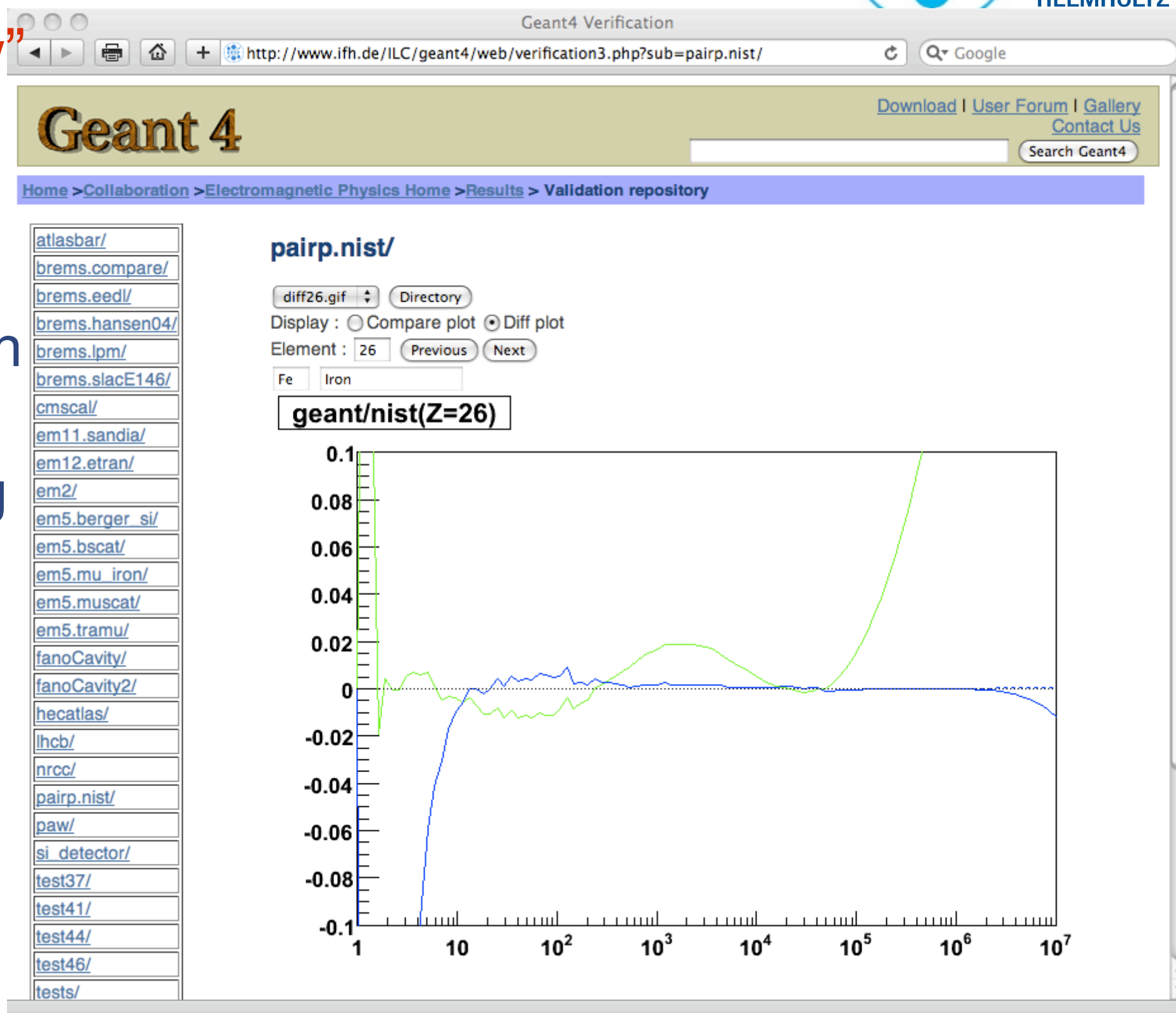
"Interactive View"

– brems.eedl, atlasbar, cmscal, lhcb

– arbitrary comparision using root-input data
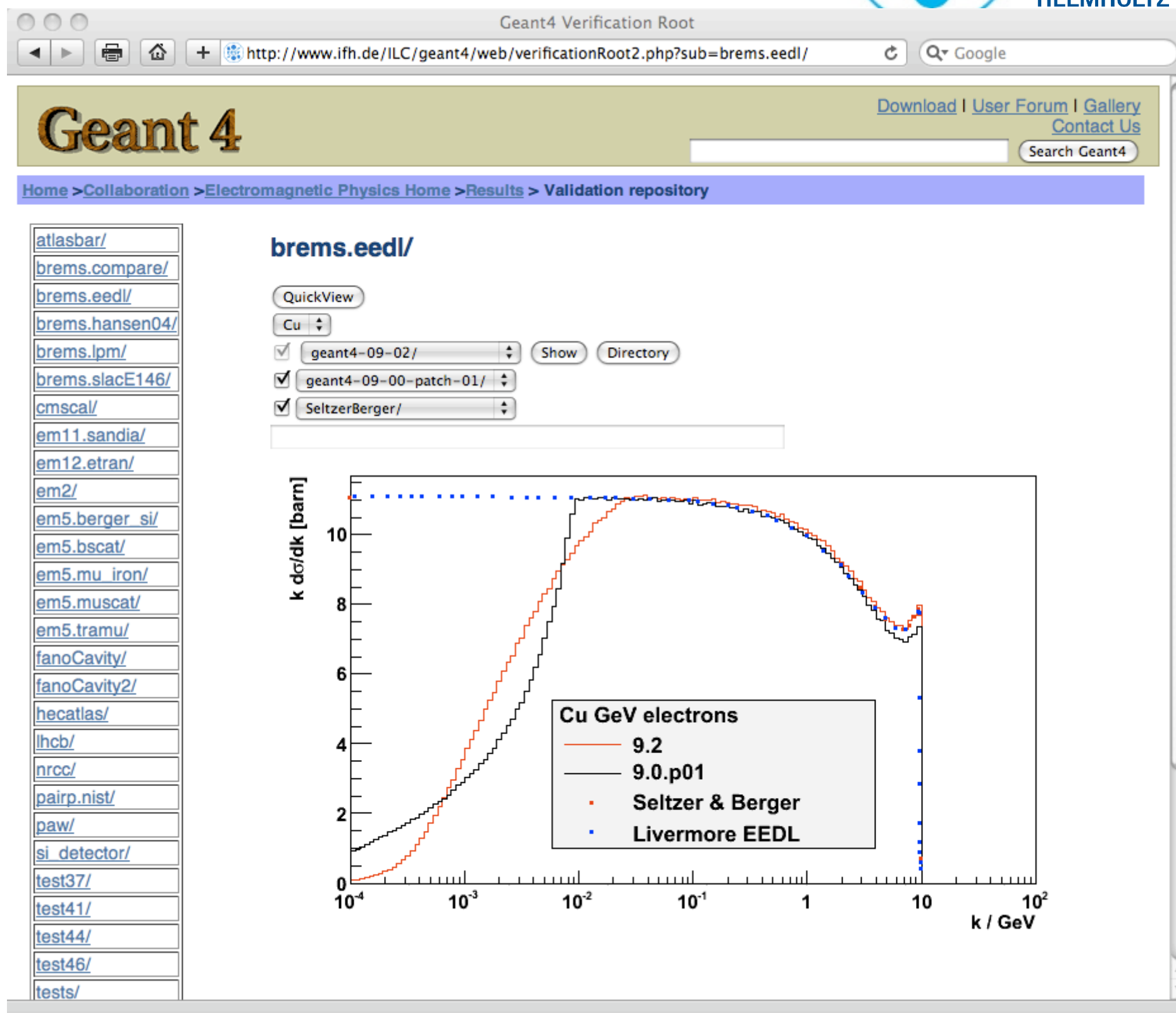
- "Quick View"
  - provides web interface for a more simple access to existing pictures
  - easy customizable via XML file
  - uses PHP and JavaScript
- "Interactive View"
  - arbitrary combination of existing results to create new comparison plots
  - uses PHP, JavaScript and PyROOT

- 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.