

# Notes on the RPG (Re-Parameterized Gheisha) Model

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# Re-Parameterized Gheisha Model

- Proposed as a replacement for LEP
- Maintain basic LEP/Gheisha concept, but
  - correct all known problems of LEP
  - use the best, most up-to-date cross sections
  - improve the parameterizations
    - use mostly medium energy data instead of high energy data used in original Gheisha
  - streamline and objectify the code

# The Need for Such a Model

- LEP model is clearly inadequate at low and intermediate energies
  - missing physics (Coulomb barrier, conservation, nuclear details)
  - although some validations (shower shapes) show good agreement with LEP, many unit tests do not
  - bugs, errors and fixes are building up
    - most fixes not implemented in order to avoid changing the parameterization of the model
- A new model would
  - cover all the particles and energies now covered by LEP
  - conform more to OO and Geant4 coding principles
  - allow us to take advantage of recent Geant4 improvements

# Model Requirements

- Use more object-oriented style
  - still lots of Fortran-like constructs in LEP
- Maintain high speed of LEP
- Handle inelastic scattering from 0 to  $\sim 20$  GeV
- Enable smooth merging with HEP, QGS, or FTF
- Use correct physics whenever possible, except when there is a large speed penalty
  - charge, 4-momentum conservation
  - relativistic kinematics

# Progress So Far

- New rpg/ directory recently tagged
  - first development version now available
  - model names are G4RPGPiPlusInelastic, etc.
- G4ReactionDynamics (in LEP)
  - code for generating hadron momenta in collision including hadronization and resonance scattering
  - > 4000 lines of code
  - in RPG this is broken into several smaller units
- Implementation base classes used for the many methods common to all LEP models

# Much Yet To Do (1)

- Replace KNO algorithm for multiplicity and particle type with partial cross section data (as in Bertini)
  - removes one level of parameterization
- Add Coulomb barrier
  - already done in test version of LEP
- Replace binding energy parameterization with Geant4 calculated values
- Reduce number of models
  - now: one LEP model for each particle type
  - plan: one model class for all pions, one for nucleons, etc.

## Much Yet To Do (2)

- Replace GHEISHA-style boosts, etc. with CLHEP versions
- Implement correct quasi-elastic behavior
- Use G4Nucleus class to take care of proton and neutron counting, excitation energies, etc.
- Model tuning
  - the biggest job

# Tuning the Model

- Use data sets at
  - 0.2-0.8, 1.5, 2.5, 4.0, 8.9, 10, 12.9, 15.0, 20.0 GeV
  - for incident  $\pi^+$ ,  $\pi^-$ , p, n and some K
- Use primarily double-differential invariant cross sections
- Specific features requiring tuning:
  - fragmentation code
  - resonance formation and decay
  - particle suppression codes
  - nuclear de-excitation



# Development Schedule

- Depends on number of people involved
- Tentative schedule for 2008 (for nucleons and pions)
  - development: present – March 08
  - first comparison to data: March 08 – June 08
  - tuning: June 08 – October 08
  - first public release: December 08
- Kaons, hyperons, anti-particles will follow in 2009
  - draw on Bertini experience
  - attempt a correct description of oscillations
  - a better parameterized description of anti-nucleon interactions