Updates on requirements from previous TF meetings

Geant4 Technical Forum
March 10th, 2009

J. Apostolakis, M. Asai (SLAC)
on behalf of Geant4 collaboration
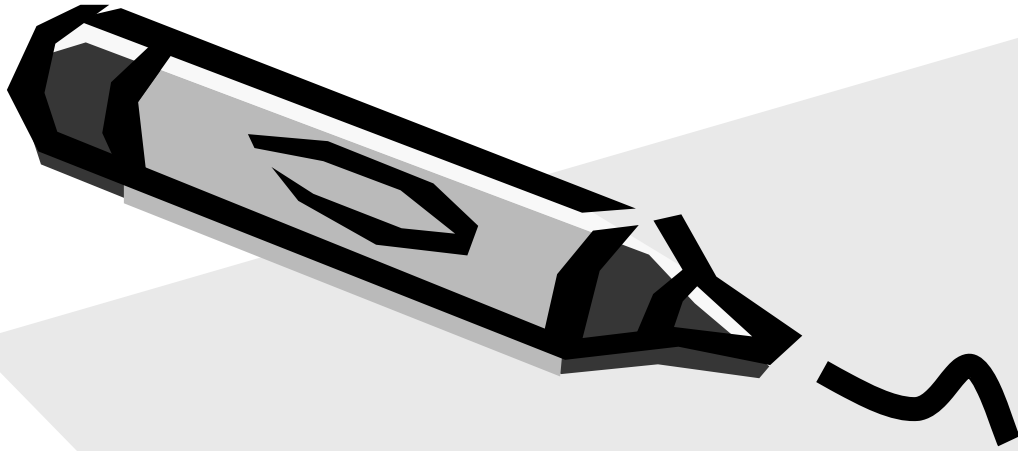
v1

Outline and links

Outline
- Update on requirements for which the status has recently changed
- Open requirements: previous update July 2008
- Long-term requirements: previous update July 2008

Some links
- Previous updates at Technical Forums can be found at http://cern.ch/geant4/technical_forum/
- Updated work plans and expected release schedules will be made available at http://cern.ch/geant4/support/planned_features.sh tml

Recent updates

1503: Packaged physics lists with low energy EM processes

Requester: Dennis Haggerty (Johns Hopkins U. Appl. Phys. Lab.)
Responsible: S. Incerti (new June 08) – was M.G. Pia
- Suggested to base them on ones in advanced examples

Status (July 2008, V. Ivantchenko)
- Additional, experimental, "option 3" EM builder introduced (in 9.2 beta) using 'Standard EM' models with parameters chosen for most precision

Status (Mar 2009)
- The convergence of low-energy and standard EM processes to a common design is underway.

- Plans in 2009 are to create new, packaged physics lists incorporating standard and low-energy processes
  – And to start validating key aspects

From Space Users meeting (Nov 2006)

4
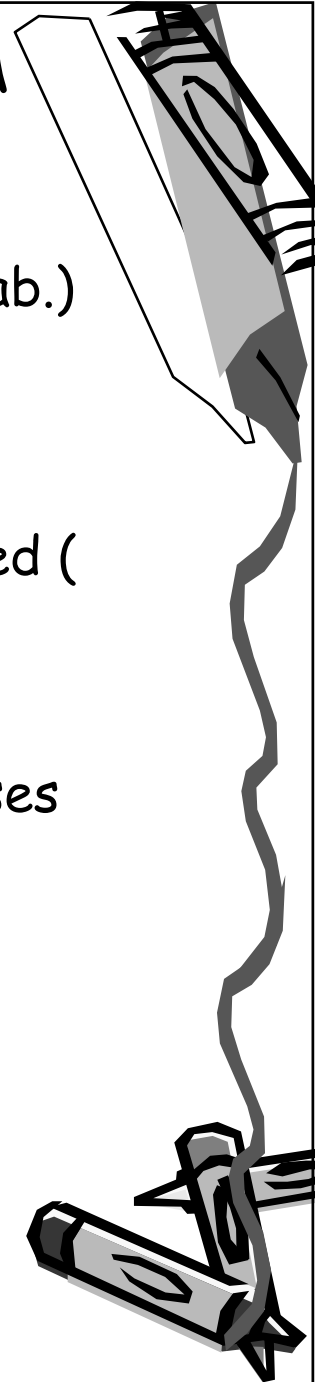
# Req.1202: Alternative models for intermediate energies

Responsible (new): D.Wright (hadronics)

Requestor: HARP

Description: "HARP requests additional hadronic models in the energy range of 1-15 GeV, as alternative to the parameterised (LEP) models.

Status (July 2008): Ongoing

-June 2008:The FTFP model has been extended and refined for proton and pion-incident interactions starting from ~3 GeV

- A reparameterization of the LEP models started

  – New name: RPG = Reparameterised Gheisha Models.

    • First release was scheduled for Dec 08

    • Jan 09: Resource limited - not 1st priority
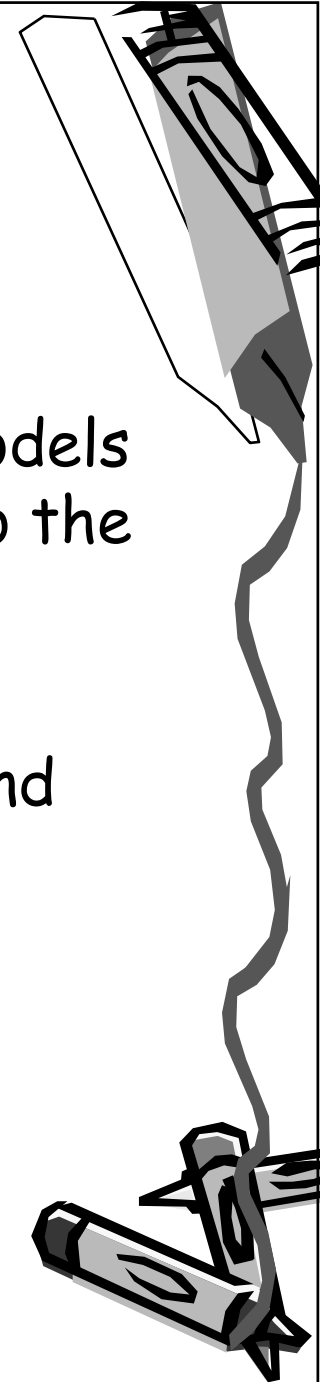
Req 1102: Identifying a process efficiently

Requestor: Atlas, CMS, LHCb (W. Pokorski)

Responsible: H. Kurashige, V. Ivantchenko, D.Wright (new)

A process (physical or 'general') must hold an identity (id) that can be used to determine

- To which class of process (EM, hadronic, optical, decay, 'transport', biasing, ..) it belongs
- which physical process it models (eg Compton, photoelectric, Bremsstrahlung, ..)
- Currently NOT the identity the particular process (G4Transportation): This part is postponed (Nov 2007)

Status (Dec 2008):

- Design revision to add this information agreed.
  - 'Infrastructure' revisions tested (Mar 2008)
  - Implemented in Standard EM processes (9.2 beta, Jul 08).
  - Included in all processes (9.2, Dec 08)
  - Propose to close (Mar 09) - with main requirement fulfilled

Req.704: Neutron data for additional elements

Originators: (BaBar, Vanderbilt)

Responsible: T. Koi

- BaBar needs Nd (Neodymium) and Sm (Samarium) added to neutron data library.
- Vanderbilt ask for As, In, Ge, Ga, Sb, Hg, Cd, Te, and Gd.

Seconded by ESA.

Status (mid-2006)

- As, In, Ge, Ga, Cd, Te existed already in G4NDL3.7
- Gd (in 3.8, Feb06), Nd, Sm, Sb – also Tc and Hf added
    - Added in G4NDL3.9 (June 2006, with G4 8.1)
- Data for Hg is not available since G4NDL3.12 (data from JENDL 3.3)

Included in release 8.2 (Dec 2006):

- Thermal Scattering files
    - H within H2O, Graphite H within Polyethylene are prepared
- JENDL High Energy files
    - H(1), C(12,13), O(16), Mg(24,25,26), Al(27), Si(28,29,30), K(39,41), Ca(40,42,43,44,46,48), Fe(54,56,57,58), Cu(63,65), Zn(64,66,67,68,70) are prepared for neutron-induced reaction cross sections.

Status (Mar 2009):

- Data provided for all available, requested natural elements (Z <= 92)
- Propose to **close**
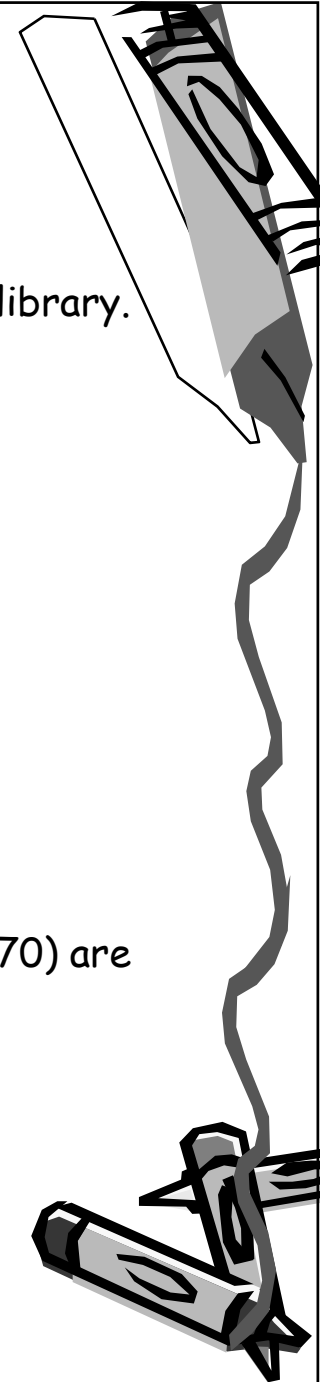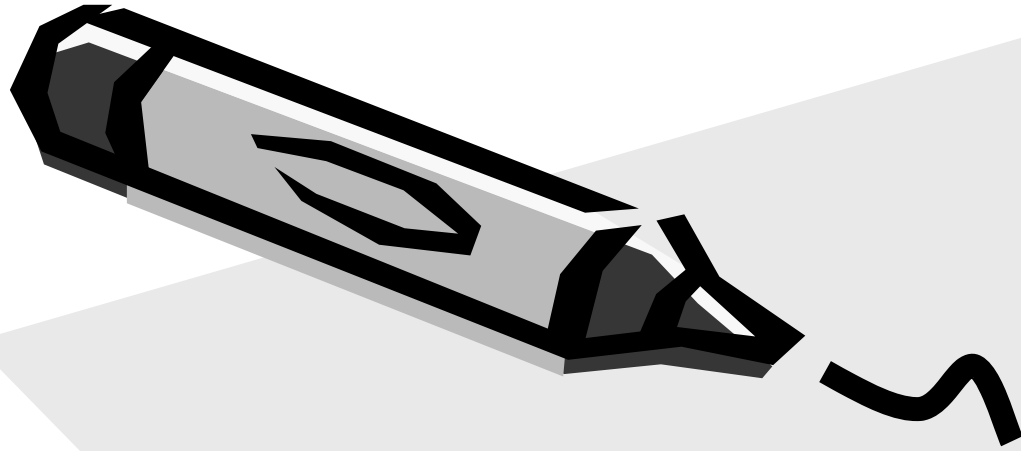
Longer term requirements

## 1. Closed or proposed to close

Requirements recently closed

Proposed close July 2008 - now closed

Delivered:

- 0304: Geometry construction
  - input from external models via GDML
- 0502: Treatment of particles that get stuck during simulation
- 0601: More details in error messages
- 0605: Adding touchable to secondaries

Improved:

- 0303: Performance of G4
  - Note: Ongoing process of improvement underway
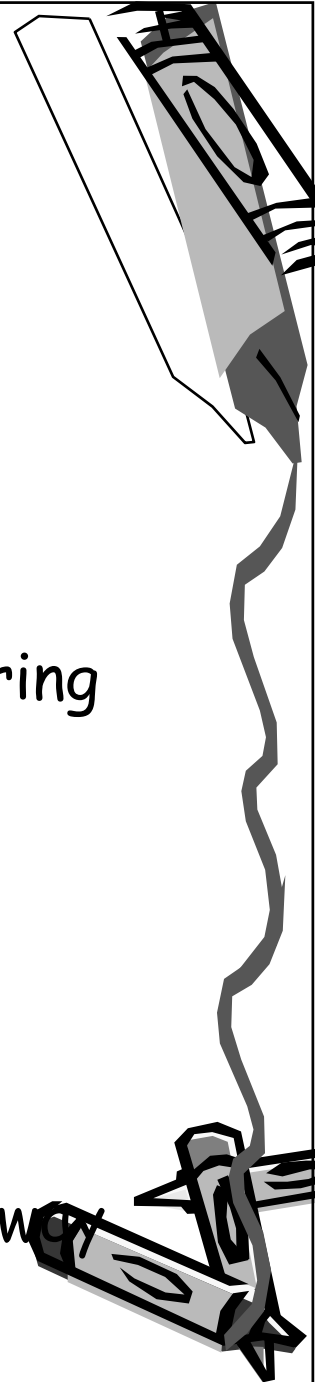
# Req.0106 : Setup statistical test suites for most sensitive physics quantities

Responsible: J. Apostolakis, A. Ribon

Status (2007):

- A first test suite for calorimetry quantities has been created. It measures longitudinal and lateral shower profiles for hadronics.
  - For several materials taken from LHC calorimeters.
- SLAC is continuously monitoring some variables most sensitive to BaBar and GLAST experiments.

Update (July 2008)

- Calorimeter regression tests are standard part of release process
- Propose to close (Mar 2009)
  - any new requirements for observables or setups? Can open new request
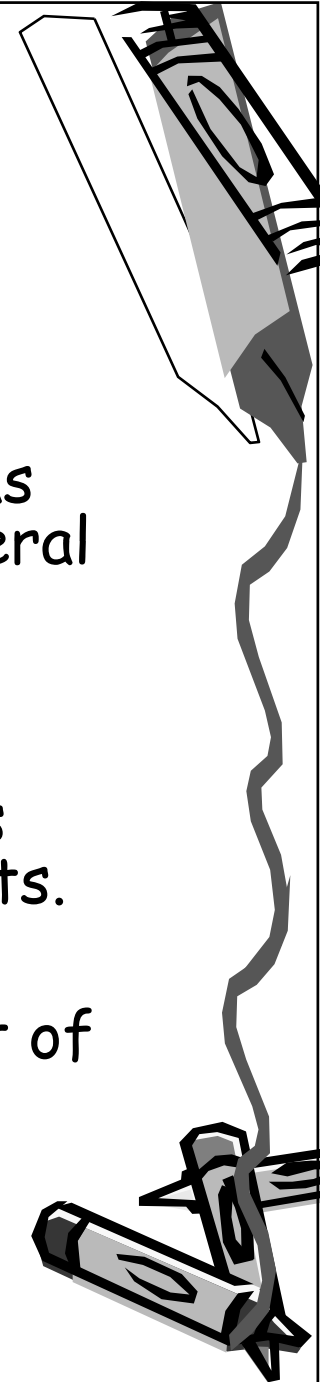
1501: Categorize deposited energy by process.

Requesters: Vanderbilt Univ., seconded by ESA and NASA – for Single Event Effects.

Categorize deposited energy in G4Step by process or separate energy into ionizing and non-ionizing parts

Context: Convert energy deposition into electron-hole pairs and simulate the output pulse from semiconductor devices in the space environment.

- G4Step used to have only total energy deposition for step
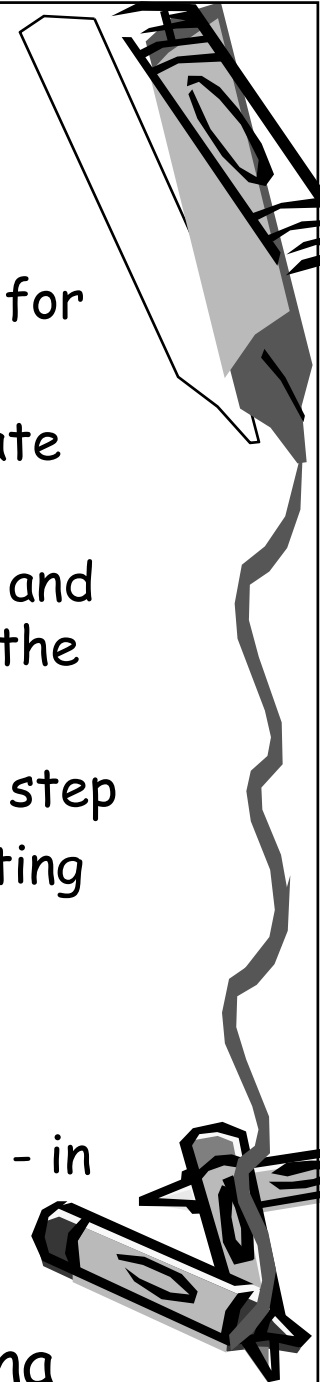 - Energy lost by post step actions are not contributing to electron-hole pairs.

Status (Feb 2008)

Dec 2007: EM physics process to contribute to this.

Feb 2008: Fixes to NIEL released (9.1 patch 1), and pending - in upcoming 9.1 ref-02

Mar 2009: Propose to close.

From Space Users meeting (Nov 2006), Pasadena

1302: Message processes in physics list

Requestor: M. Stavrianakou, CMS

Responsible: G. Folger (tbc)

Context: Wish to message physics list or its processes, to control some aspect.

- – Control via messenger handles is not enough.
- Example: verbosity control in hadronics. Provide ability to tune controls (threshold, cut setting etc)

Old title: Making available process/physics lists "controls".

Status (July 2008): Partially done. Rest not scheduled

- Verbosity level can be set in constructor.
- EM cut is tunable via G4VModularPhysicsList::SetCuts()
- Threshold for switching models is NOT tunable parameters!
  - – Would break ability to compare btwn users
  - – Users must create variant PL to change parameters

Question (Jul 2008) : Are **handles** to PL & its processes still required (and why?)
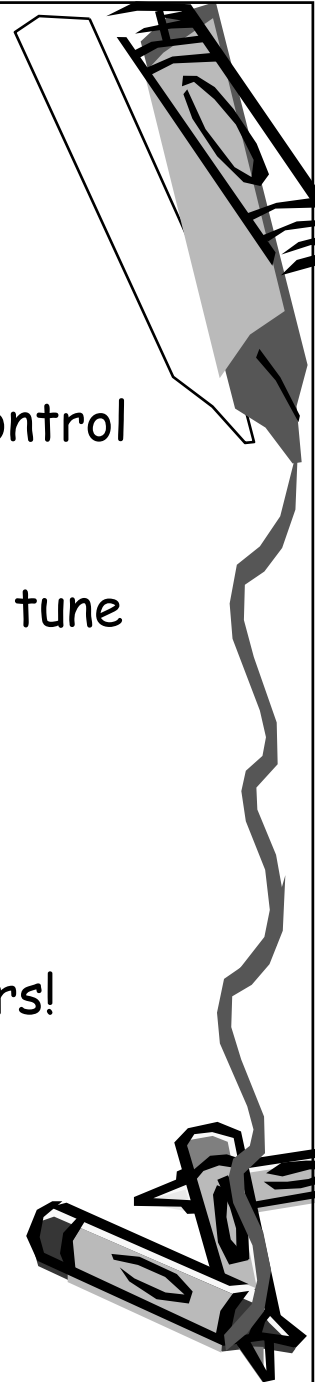
Req.0402: "Intuitive" documentation of the physics lists

Responsible(s): D. Wright / G. Folger

Requestor: ESA (G. Santin)

Date of request: May 2004

Description: "Intuitive documentation (maybe in graphical form) for each physics list to show, for a given particle, which model is active over which energy range. It could also be printed out by the list in ASCII format, with a loop over inserted models."

Status (2007): Hadronics: accepted, **open**.

Update (July 2008): Ongoing

• Development preview included in 9.2 beta to enable registration of model ranges in new classes. Printing per particle.

• Next steps are to extend coverage of processes.
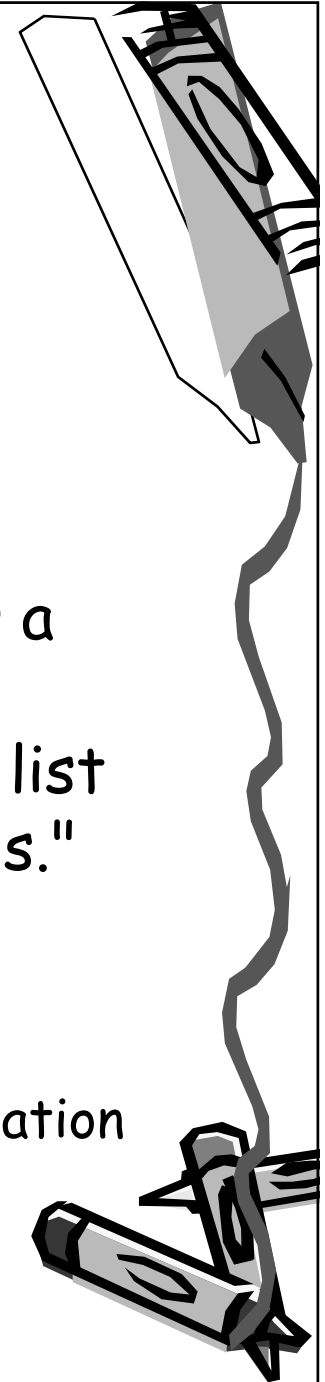
Req.0309: Provide documentation on the technical aspects of all available physics processes

Responsible: D. Wright / V. Ivantchenko (new) / S. Incerti (new)

Description: "All available physics processes, models, cross-sections, etc., should provide documentation of the technical aspects of the implementation:
 - details of the expected behaviour of a model should be provided (for example how incoming and outgoing particles are handled). This applies to both hadronic and electromagnetic processes."

- Concrete requirement for behaviour of secondaries of hadronic process was fulfilled (Req.??).

- Physics group coordinators are open to suggestion of concrete issues and potential improvements.

- Status: concrete issues addressed – general request beyond G4 resources

- Proposal (July 2008):
  - Propose guideline to clarify new or unusual technical features of models;
  - If a guideline is agreed, close this requirement
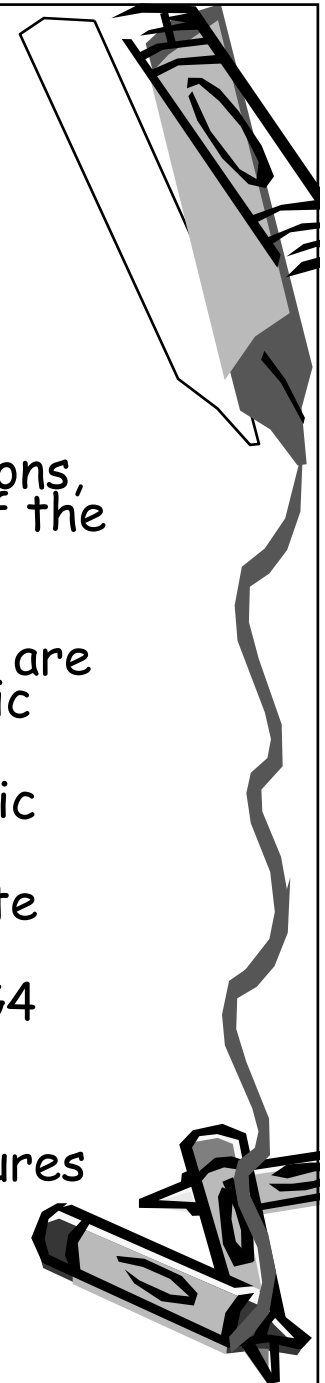
A guide to the 'Status'

- Potential status of long-term requirements:
    - Under study
        - Impact not yet understood
    - Under development
        - Ongoing
    - Not resourced
        - Awaiting / lacking resources
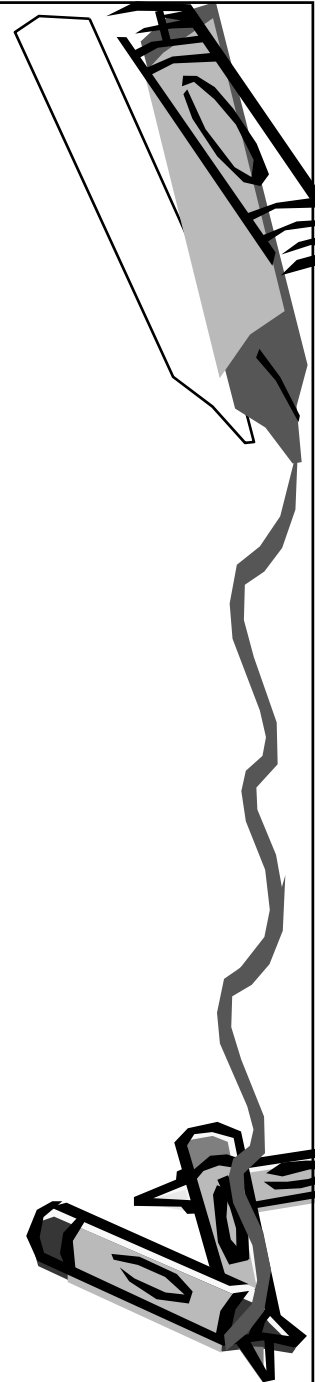   - Not scheduled
    - Conflicting
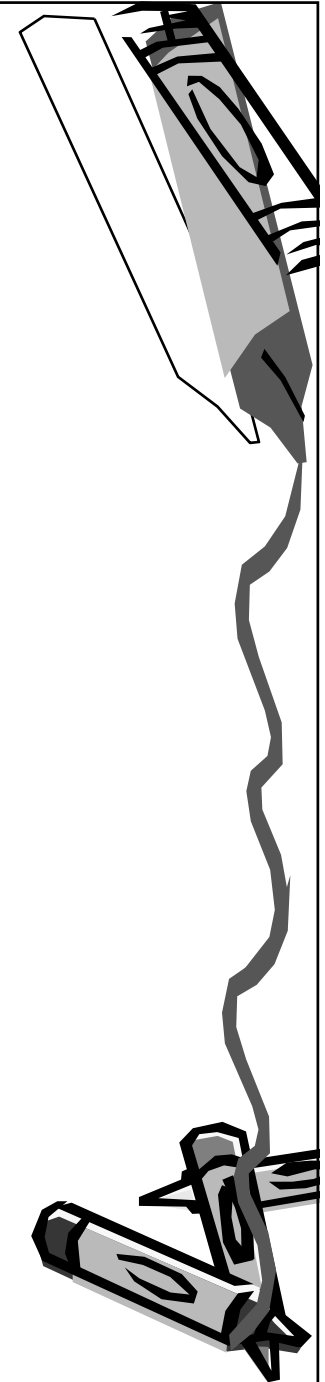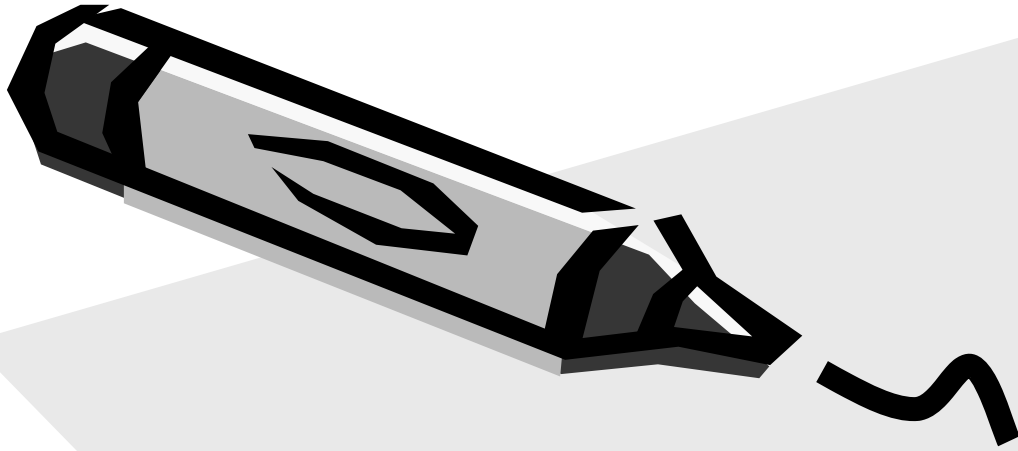
Latest requirements / requests

Requests from Underground Experiments

Requests collected at
Technical Forum Sept.15.2007
(Meeting 20)
@ Hebden Bridge

2001: Missing from Neutron_HP

Requested by H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS)

Responsible: T. Koi (SLAC)

- <u>E + p conserved</u> event-by-event in NeutronHPInelastic
- <u>Residual nucleus</u> should always be emitted (when it exists)
  - e.g. Ge(n,2n), capture (n,>1γ)
- NeutronHPInelastic produces no gammas in some channels
  - E.g. (n,α) and (n,p)

Status (Nov 2007)

- In neutron_HP E/p conservation
  - is good in HPElastic;
  - A simple improvement has been suggested for (n,n'g).
    - TK will look into this, since it is the probably the most important case for the community.
  - For the general case the data is not adequate to provide it.
- Other reports regarding the missing residual nuclei will be investigated (along with bug reports).
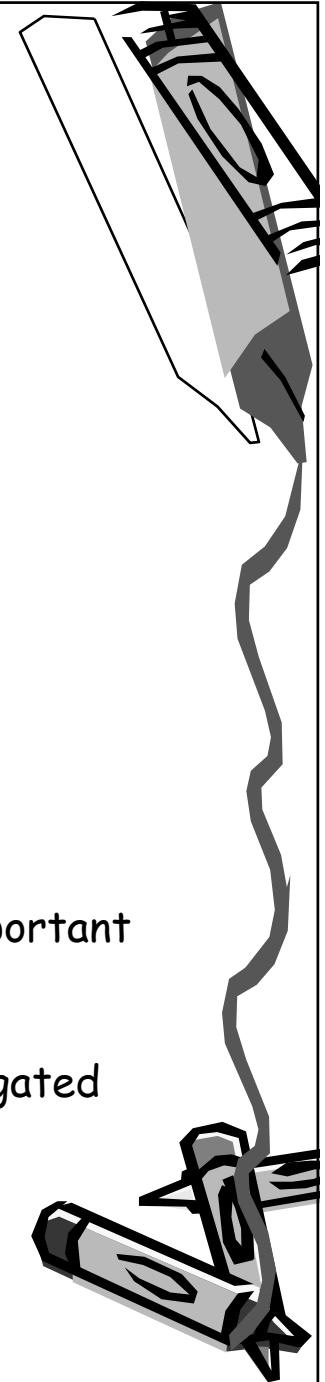
# 2002: Improve Neutron HP database & its doc.

Requestors: H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS) - for 'underground' users

Responsible: T. Koi (SLAC)

- Can we avoid <u>natural abundance</u> elements in database?
- Clarify HP <u>database format</u> (especially final state)
  - Document format used
    - Users want to extend database, and they need to understand it!
    - Independent database management tool?

Status (Nov 2007)

- The issue of natural abundance isotopes will be looked at
  - it is suggested that it should generate a warning (missing isotopes already do).
- Currently planning to replace the existing module and the G4NDL format.
  - Moving to new LLNL 'module' for neutrons based on ENDL database (instead of ENDF-VI). This is expected to utilise the full range of data provided in this format
    - new elastic model is planned for 2H 2008 (second half), and
   - the inelastic model predicted for 1H 2009.
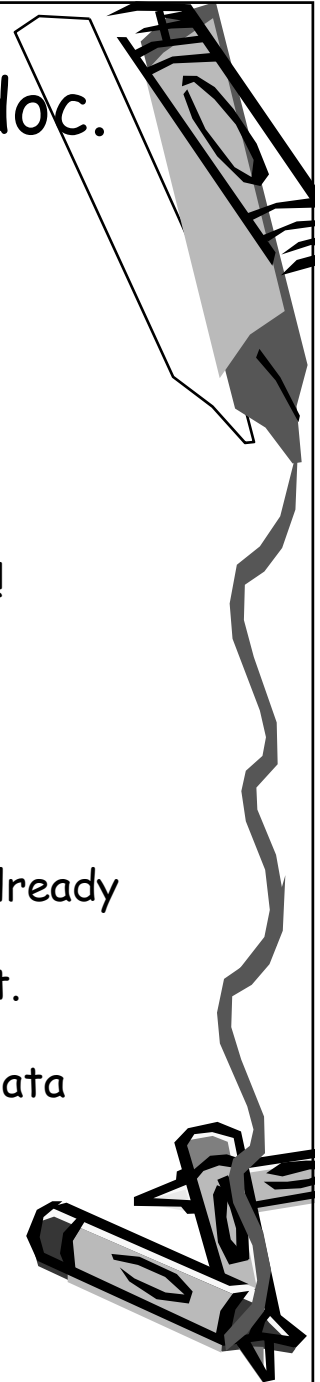
2003: Muon induced neutrons

Requested by H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS)

Improve and validate muon-nucleus models

Original Input:

- Continue development & validation of <u>muon-nucleus</u> models
  - QCollision + QCaptureAtRest – maybe produces those missing neutrons!
  - Validate inelastic XS, underground muon spectra, depth-intensity relation, etc
- Consider <u>testing</u> for neutron yields with release
  - Disseminate validation results
    - Hadron cascade models – too many gammas, too few fragments?
    - Ion cascade models – to cope with more fragments
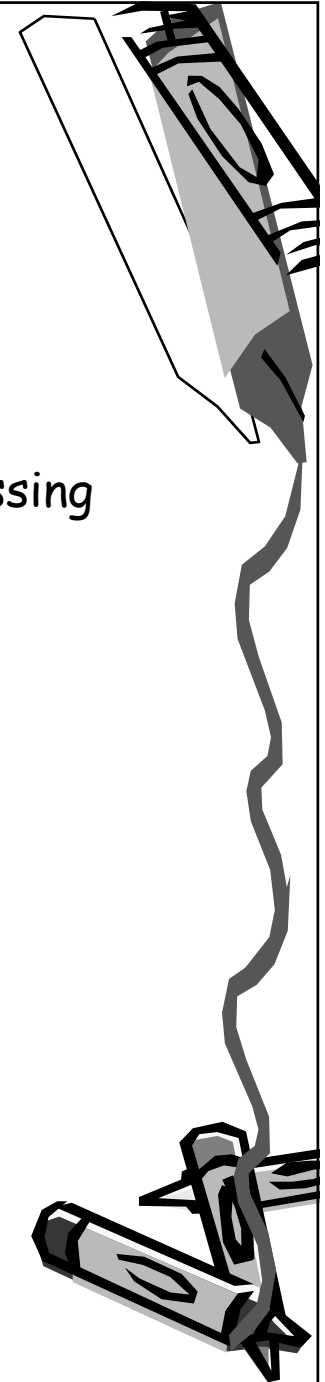
2004: Radioactive decay module

Requested by H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS)

- Radioactive decay module
    - Refine interface to atomic de-excitation (x-rays and Auger)
    - New event generators ($2\nu-2\beta$ decay, non-trivial sources)
    - Small BR decay probabilities
    - Shape of beta spectrum for forbidden transitions (e.g. Ar-39)
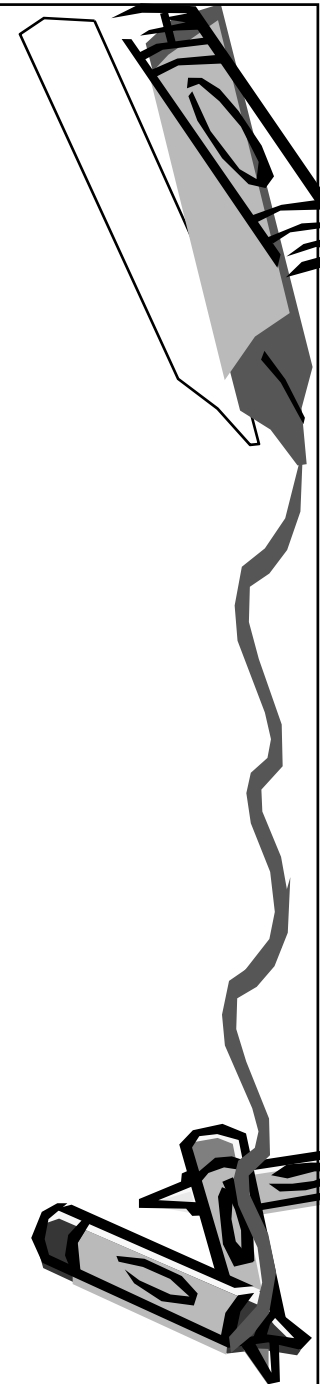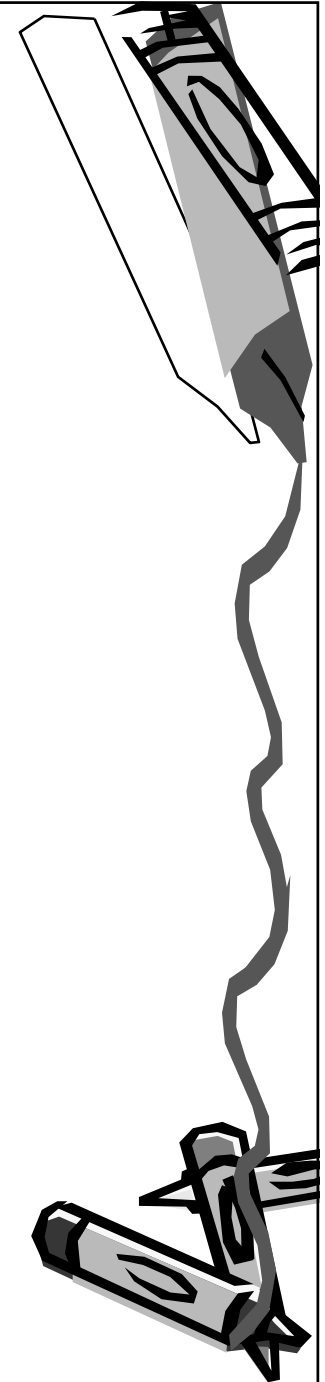
2005: Radioactivity

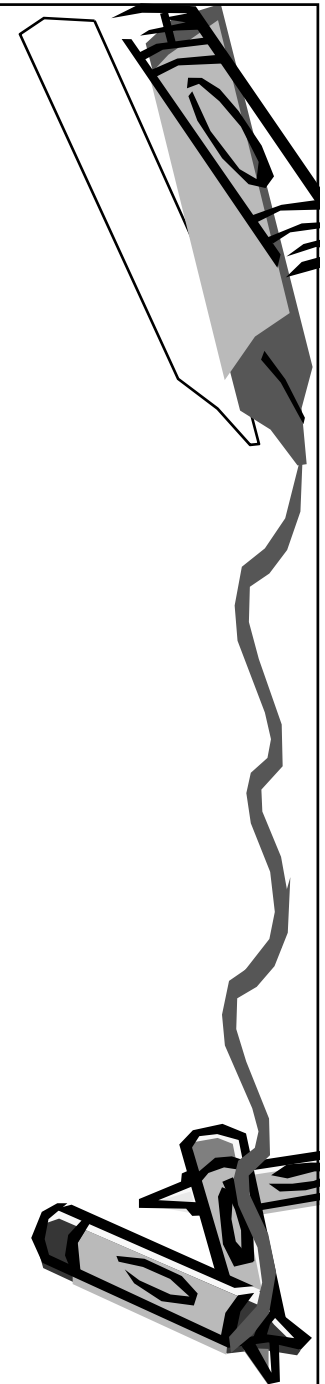Requested by H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS)

Request:

- Support <u>Metastable</u> states
    - "The time is right in light of PDG discussion"

- <u>Angular correlation</u> in gamma cascades

2006: Data driven (α,n) and (p,n) reactions

Requested by H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS)

- (α,n), (p,n) <u>reactions</u> – e.g. data-driven (HP-type model)
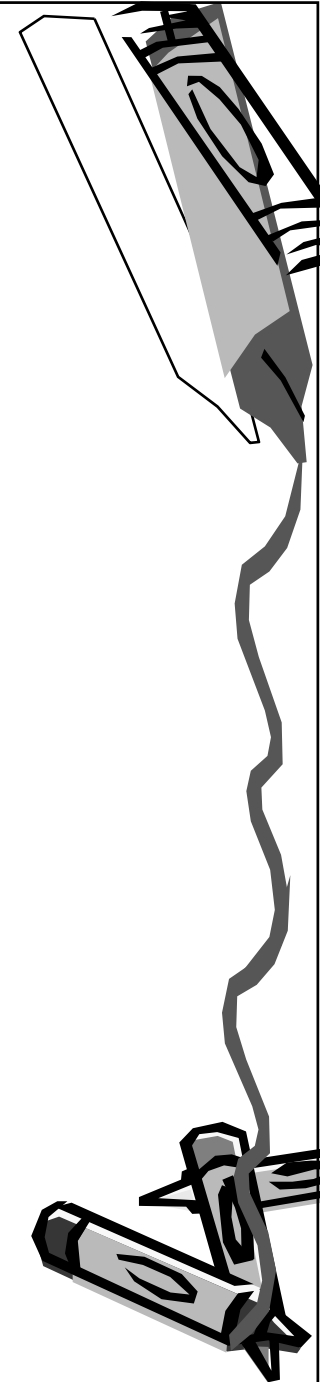 - Main neutron production mechanism in most experiments (background, calibrations)

2007: Gamma cascades

Requested by H. Araújo (Imperial Collage) & Luciano Pandola (INFN/LNGS)

Responsible(s):

- Provide <u>Angular correlation</u> in gamma cascades

1502 – Support multi-core processing

Requested by Francisco Garcia (HIP).

Responsible: G. Cooperman

- Support for running multiple events simultaneously utilising two or more cores, utilising fewer resources (memory) than two separate processes.

Status (July 2008): Under Study

- Analysis has identified potential approaches, and a first set of issues that would need to be addressed
  - Impact on a number of critical areas is foreseen
- Prototype(s) by GC & Xin Dong (Dec 2007; Feb 2008)
  - Grad student project
  - Several issues identified will require significant study;
    - potential changes are large;
    - Will be examined in depth in G4 first.
  - GC/XD will joined Multi-core workshop April 2008 @ CERN

From Space Users meeting (Nov 2006)
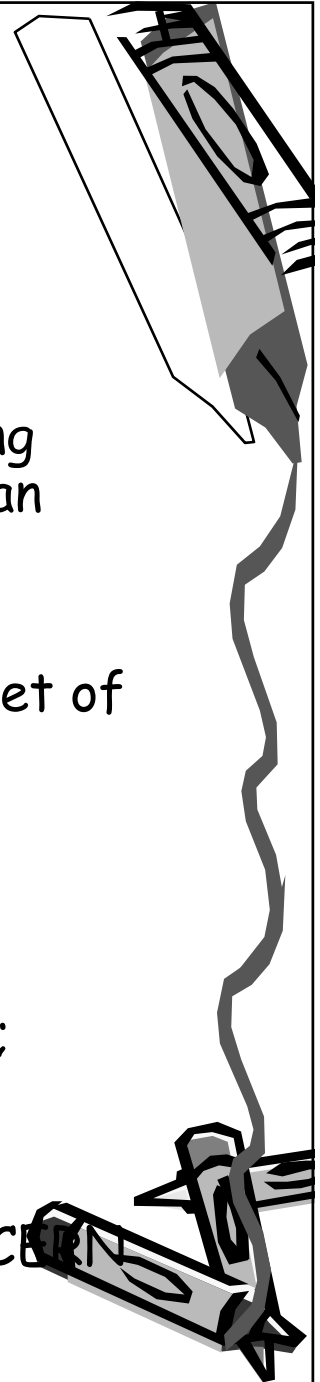
1504: Improved final-state isotope spectrum

Requester: Scott Messenger (SFA Inc. and US Naval Research Lab)

Responsible: D. Wright (new) / G. Folger / J.-M. Quesada (new)

Use case: neutron induced radiation on photo-cells.

- Request to improve final state isotope mass spectrum in Bertini and Binary cascade models

Status: Ongoing

- A <u>first validation</u> was undertaken in 2006

- For Binary, results depend largely on nuclear de-excitation models (pre-compound + excitation handler)

- Improvements in pre-compound and equilibrium de-excitation models are are ongoing.

  - Will request feedback when de-excitation improvements are ready (in monthly dev or public release)

From Space Users meeting (Nov 2006)
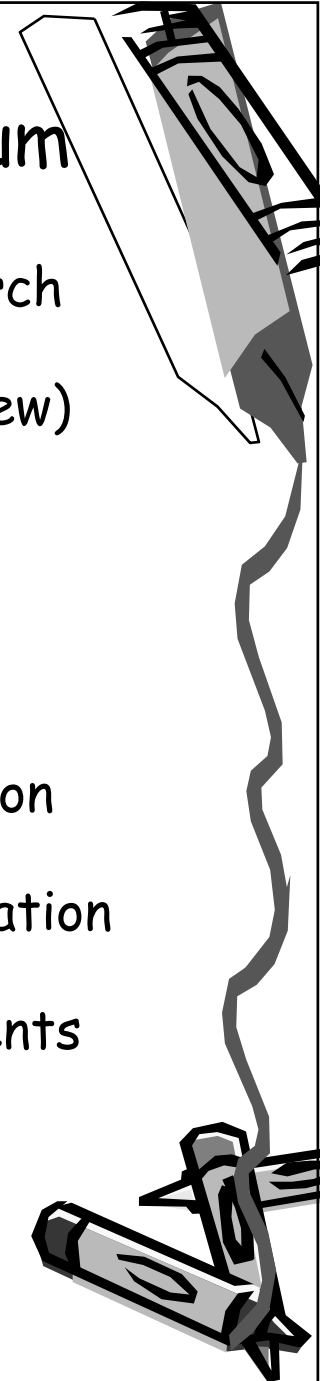
1505: Process for x-ray specular reflection

Requestor: N/A (communicated by G. Santin)

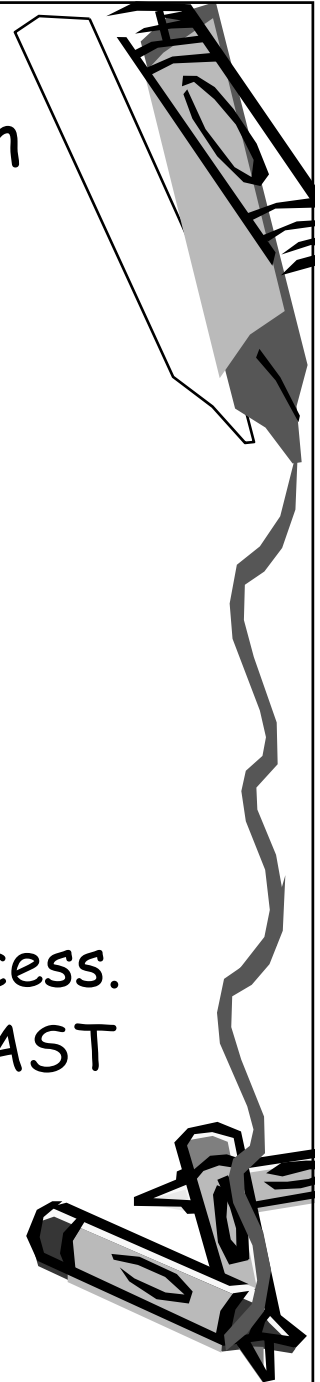Responsibles: G. Santin (ESA) / V. Ivantchenko

Add process for x-ray specular reflection

- Notes:
    - More information likely required
    - Can capabilities be borrowed from optical package?

Status

- Willing to review and integrate contributed process.
- Note: a <u>basic implementation</u> was created for CAST
- Further news awaited from ESA.

From Space Users meeting (Nov 2006)

1506: Documentation of physics lists.

Requestor(s): Space users, HEP users

Responsible: G. Folger / PL 'task-force'
- Note: this is in progress, but more effort is required.
- What physics list (PL) should I be using ?
    - How do you go from use case to PL ?
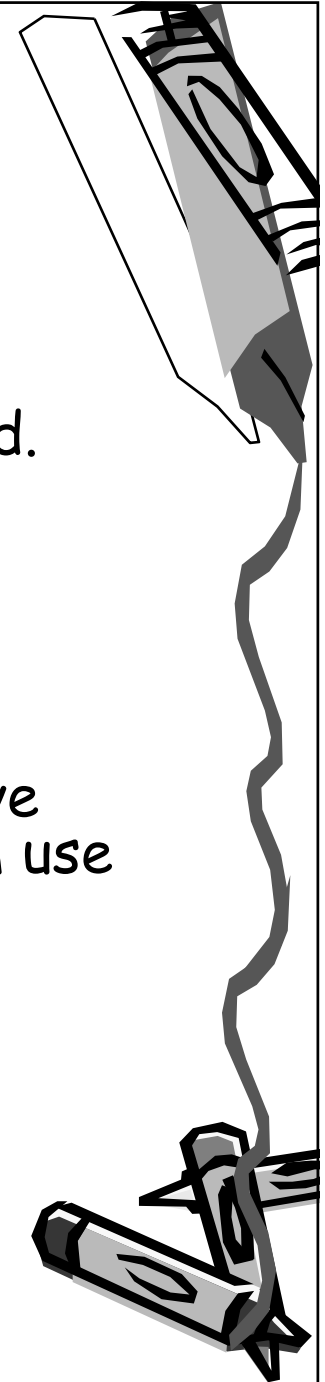   - Can dialog with users (online forum) aid this?

Analysis
- Given diversity of application domains, need to involve and work with users to document requirements from use cases

Status (July 2008): Ongoing
- Improving of PL documentation is progressing
- Online forum is active

From Space Users mtg (Nov 06) & G4 Workshop (Oct 06)

1403: Forcing decay in tunnel

Requester: GDR neutrino experiments (via Marc V., Oct 2006)

Responsible(s): J. Tinslay

- Ability to force decay of pions in decay tunnel

Status (Nov 2007):

An overview of various forced interaction techniques is at:
http://geant4.slac.stanford.edu/EBMS/material/InteractionForcing.pdf

Prototypes are currently being developed for the techniques shown in the overview

Will appreciate further, more detailed information on request from the user(s).

- Relayed from mtg with neutrino experiments (M. Verderi, Oct 2006)
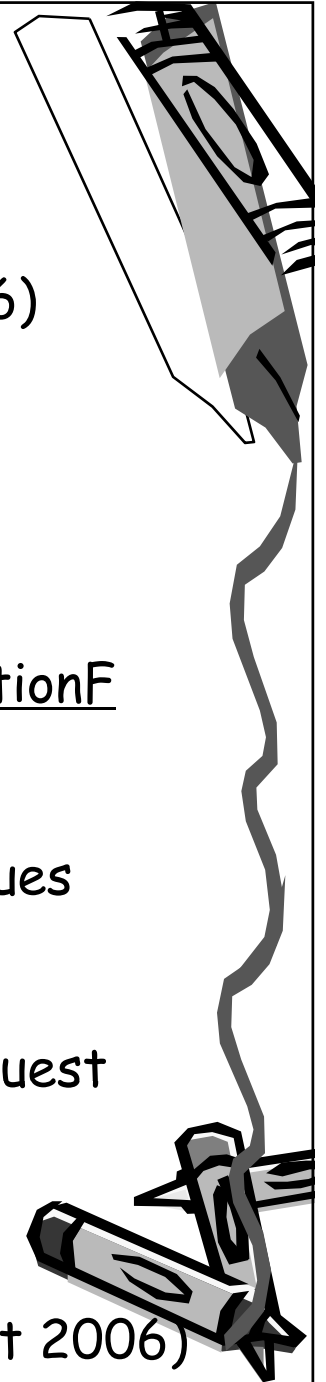
Meeting at G4 workshop (Oct 2006, Lisbon)

- Issues reported from meeting with neutrino experiments (M. Verderi, Oct 2006), which require clarification:
    - Issue with pion production from proton on Pb (at 10-50 GeV)
    - Problems encountered with Boolean solids
        - Wish to see smooth surfaces without additional edges
- Issues discussed:
    - How to communicate the ongoing validation work?

•Relayed from mtg with neutrino experiments (M. Verderi, Oct 2006)
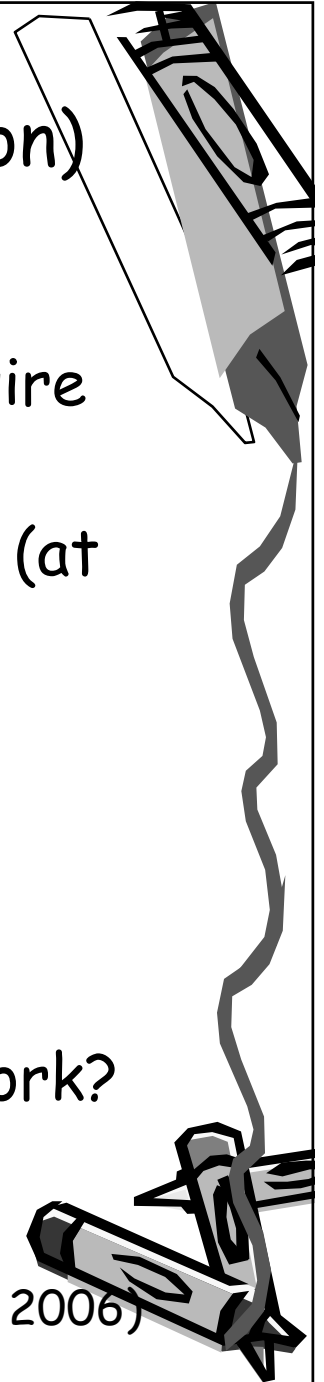
Meeting at G4 workshop (Oct 2006) – cont.

- Issues discussed:
  - How to communicate the ongoing validation work?
- User question:
  - What physics list (PL) should I be using ?
    - How do you go from use case to PL
    - Can dialog with users (online forum) aid this?
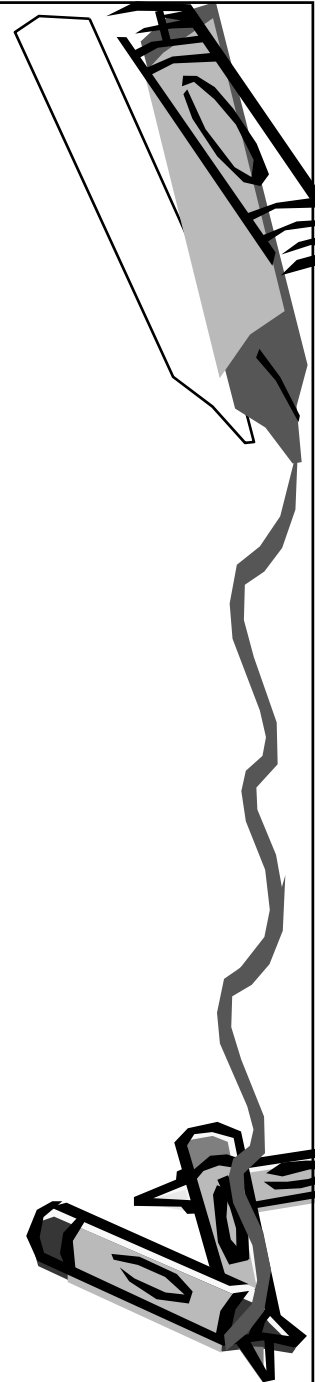   - Need to involve users to document requirements from Use Case(s)
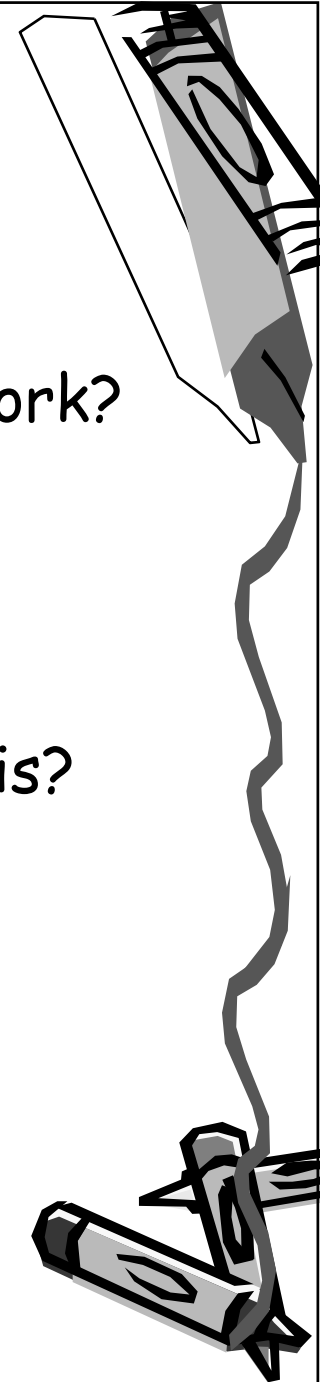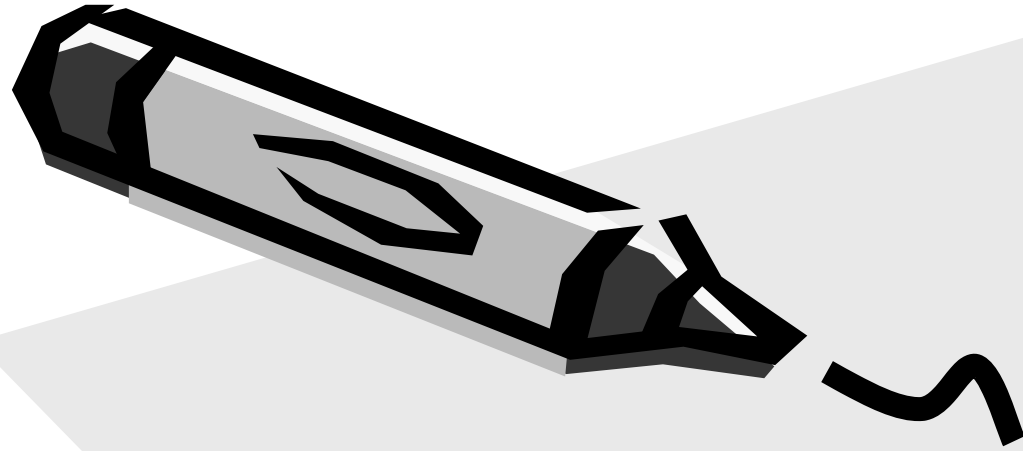
Requiring user feedback

Awaiting user feedback

- Req.702: Selective verbosity

- Req.707: Python UI

- 1404: Composite external fields

Req.702: Selective verbosity

Originator: LHCb (G. Corti)

Responsible : T. Sasaki

- "We would like more configurable debugging features.
  - It is possible to follow in details various aspects of the simulation by setting verbose levels.
  - This is very hard to use when tracking complete pp events because millions of G4Track are produced.
- It would be very useful to be able to selectively turn on such verbose for a single G4Track, a single region of the detector, a combination of the two."

Status

- New flag in G4VSteppingVerbose was introduced in v8.1
  - allows the user to toggle the verbosity on and off for each track and/or step
  - the user has to create his/her own stepping verbose class deriving from G4SteppingVerbose default verbosity class and implement this toggling.
  - Other virtual methods of actual verbosity can be kept unchanged.
- If this satisfies the requirement, we propose to close this.
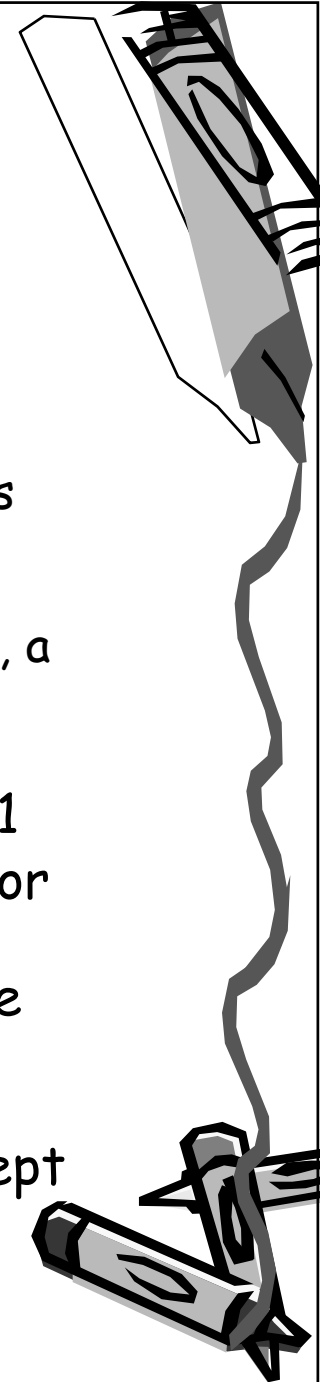
Req.707: Python UI

Originator : ATLAS (A. Dell'Acqua, A. Nairz)

Responsible: H. Yoshida

- More support for a python UI in G4 (not only the current UI/macro version).
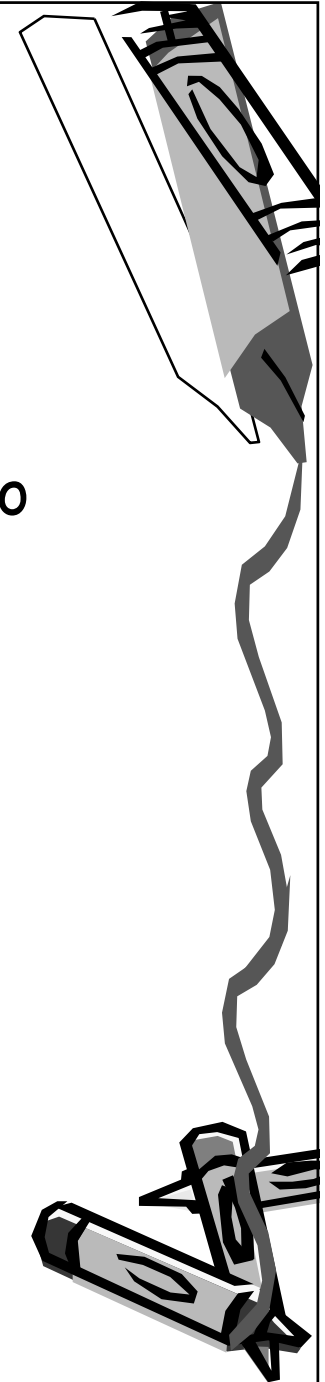
Status

- A development version now includes the a G4-Python interface
  - First implementation was released at v8.1
- Python classes provide access public methods of key classes (implementation uses Boost)
  - Currently evaluating the protection of key quantities during a run from being changed.
- Users' feedback requested.
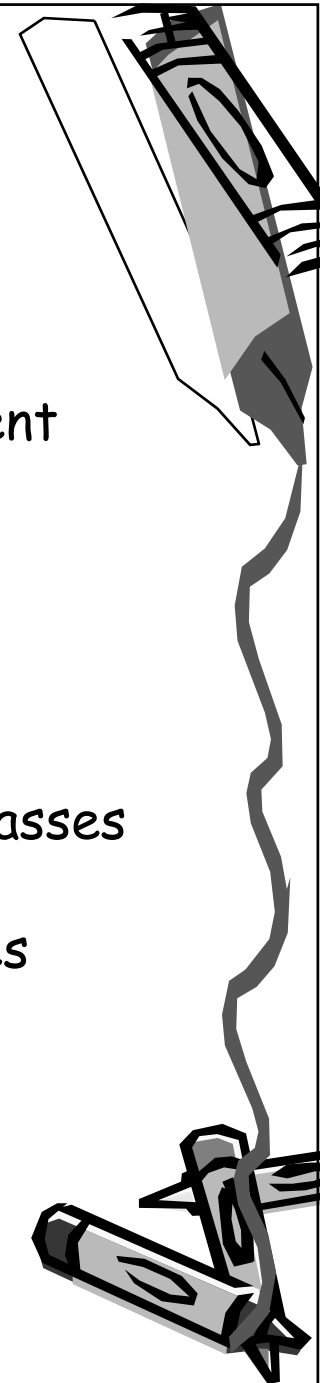
1404: Composite external fields

- Requestor: P. Gumplinger (on behalf of users)
- Responsible: P.G. volunteered
- Request for 'composite' external fields Ability to add multiple 'sources' of fields
  - Gravitational field
- Status (Feb 2007):
  - New example with a composite external field created
    - Utilised capabilities from G4beamline tool (muons.com)
- Open to feedback

Updates: July 2008
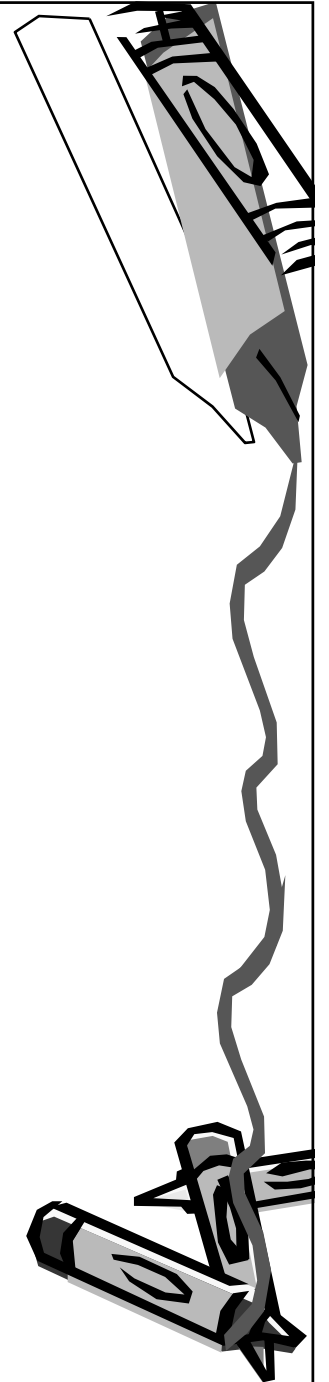
1401 Recoil ions

Requester: G. Santin – relay from Leuven Space Wrk, Fall 2005

Responsible: V. Ivantchenko

- Producing recoil ions

Status (July 2008)

- Released single scattering process, for ion incident in 9.1 (Dec 2007) providing recoil ions
  - contributed by R. Weller, M. Mendelhall (Vanderbilt Univ.)
  - Fix in 9.1p01
  - Classes are G4ScreenNuclearRecoil, G4CoulombScattering and G4UHadronElasticProcess
- Open issue
  - The definition (interface and physical value) of threshold on the recoil energy require extra discussion

January: Requested feedback from users

- If all is well, had proposed to close this at next meeting.
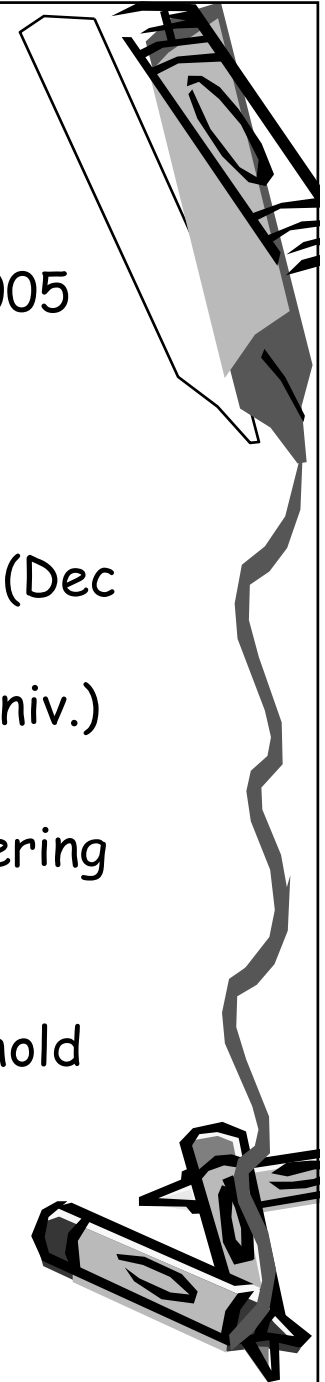
1402: Scintillation

Requester: GDR neutrino experiments (via Marc V.)

Date: Oct 2006

Responsible(s): Peter Gumplinger

- Improve scintillation process
  - Currently when using mean material, the correct description of the process is lost

Status

- Need more information
  - Scintillation properties can be attached to materials

Update (July 2008)

- G4Scintillation updated, now using Birks and other material parameters from G4Material

  - Relayed from mtg with neutrino experiments (M. Verderi, Oct 2006)
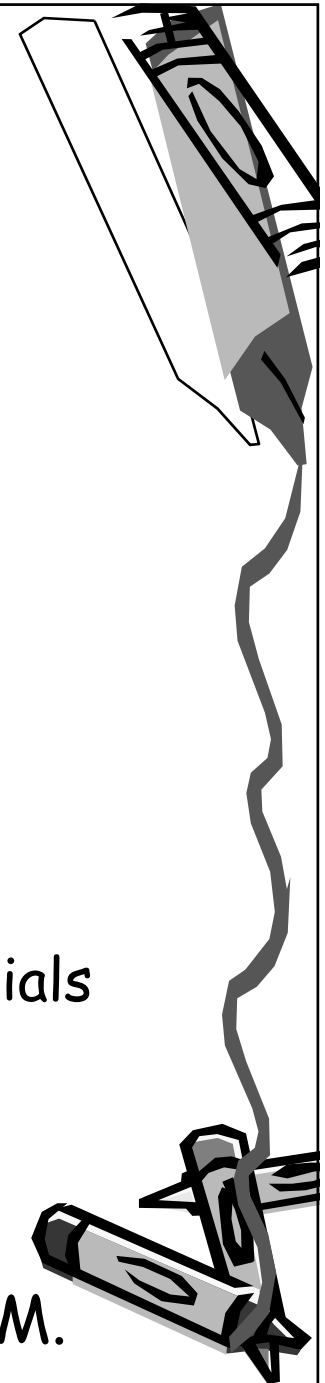
1602: Primary ionisations

Requestor: Andreas Morsch for ALICE

Responsible: V. Ivantchenko

- Having the possibility to get for each step the number of primary ionisations, their locations and the kinetic energy of the electrons.
  - This is needed for the accurate simulation of the TPC resolution.

Status (Feb 2008):

- Was included in 2007 work plans
  - Not achieved for December 9.1 release
- Scheduled for 9.2 release (Dec 2008)
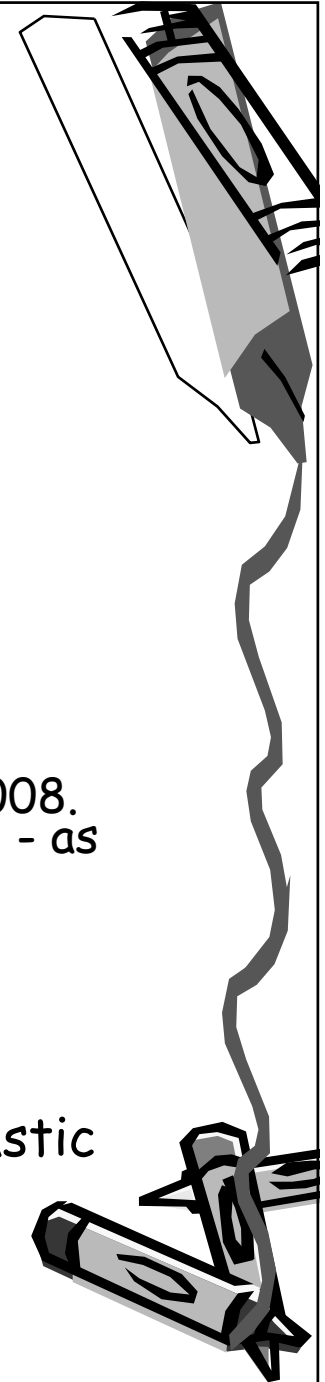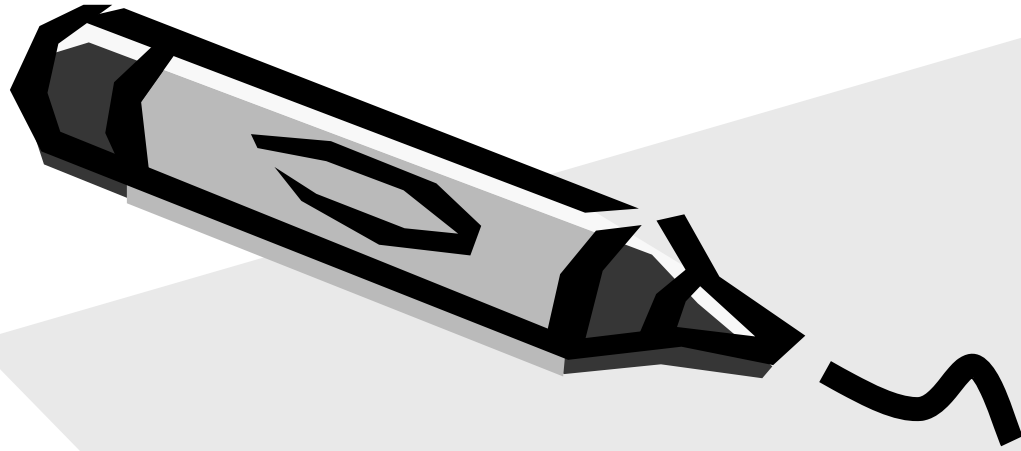
Requests / requirements Nov 2006
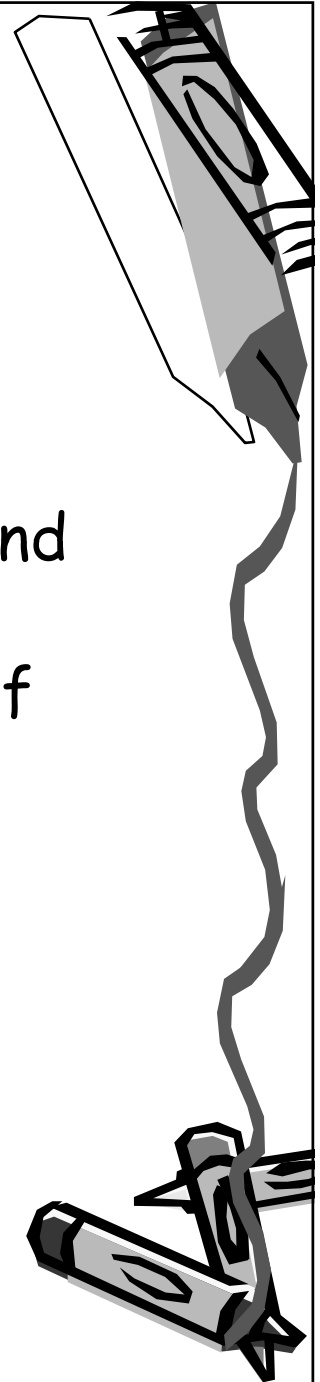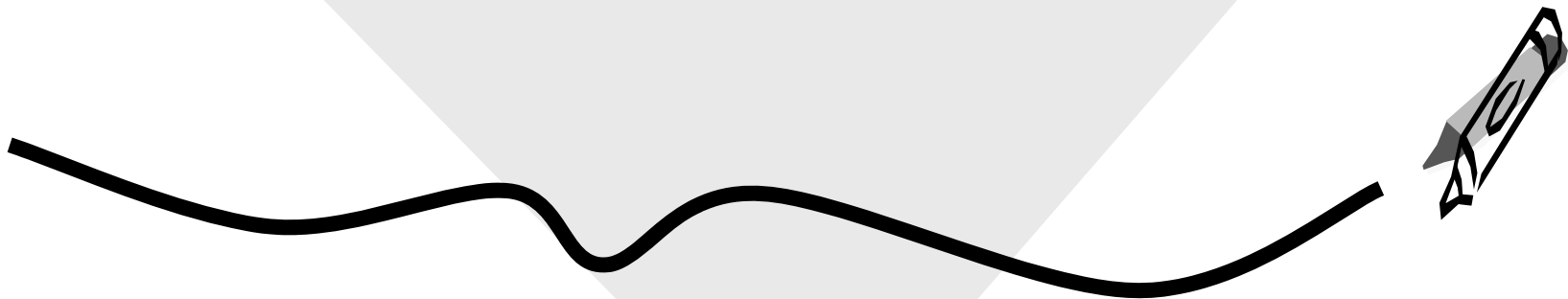
Problem report issues (from underground)

Address open <u>bugs</u>:
- Radioactivity:
  - #952: Fix in G4 9.1 (Thanks Luciano Pandola)
  - #956: Responses provided
    - Support for isomeric states would be significant extension
    - Workaround identified
    - Neutron_HP:
  - Feb 2008: an alternative model is scheduled for Summer 2008. Due to limited manpower, we plan not fix the existing model - as it is a large job.
  - #821: Missing inelastic recoils from NeutronHP
    - A first, temporary fix is in preparation.
  - Not all conservation laws will be respected
  - #675: No boost from CM->Lab for G4NeutronHPInelastic
    - Initial fix in 9.2 beta, and further efforts ongoing

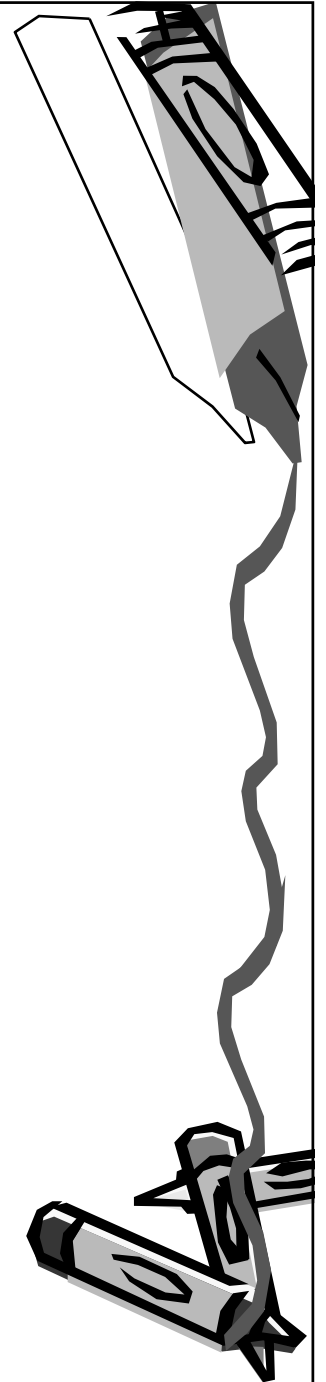Recent or revised
requirements / requests

Other requests / requirements from Mar 2006

- AUTOCAD input – (CMS / D. Stickland)
  - Input of CAD file geometry
  - potential additional issue for level of detail
UNCLEAR
- Neutron shower parameterization

Req 1103: Composite User Actions

Requestor: Atlas (A. Dell' Acqua), LHCb (G. Corti)
Responsible: M. Asai

- Provide a 'composite' action of each user action type (Run, Event, Tracking, Stepping) that can call a set of registered sub-actions.
  - These sub-actions shall be called in the order in which they are registered.

Status
- Asked for feedback & more information on requirements (April 06).
  - for the stepping action, instead of making it modular, alternative design could be allowing each G4Region to have a dedicated stepping action.
  - For event and tracking action, one modular action can kill the event/track. We need Subsequent actions likely should not be called.
- After new communication, first feedback recently obtained (G. Corti, A. Dell'Acqua)
  - Stepping action per region probably not ideal
  - Propose for calling of event/tracking action to depend on boolean return flag.
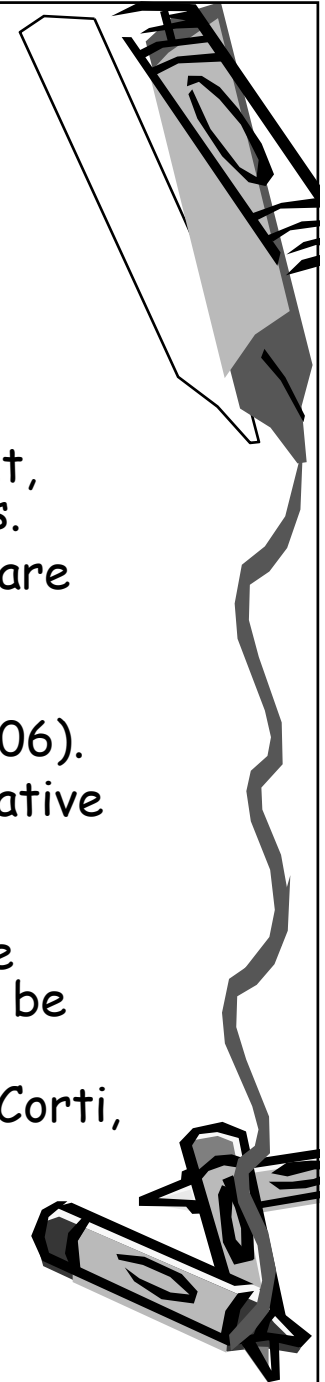
Req. 1104 Providing interaction snapshot

Requestor: Atlas, CMS, LHCb (W. Pokorski)

Responsible: T Sasaki (tbc)

- The simulation system shall provide to a "truth holder" class a snapshot of the interaction, including position, incoming particle, all secondaries created (available as single entity, eg vector)

  - Requestor: Atlas, CMS, LHCb (W. Pokorski)

- Status

  - Since release 8.2, G4Step has a vector which has pointers of secondaries created in this particular step.

  - We propose to close this request.
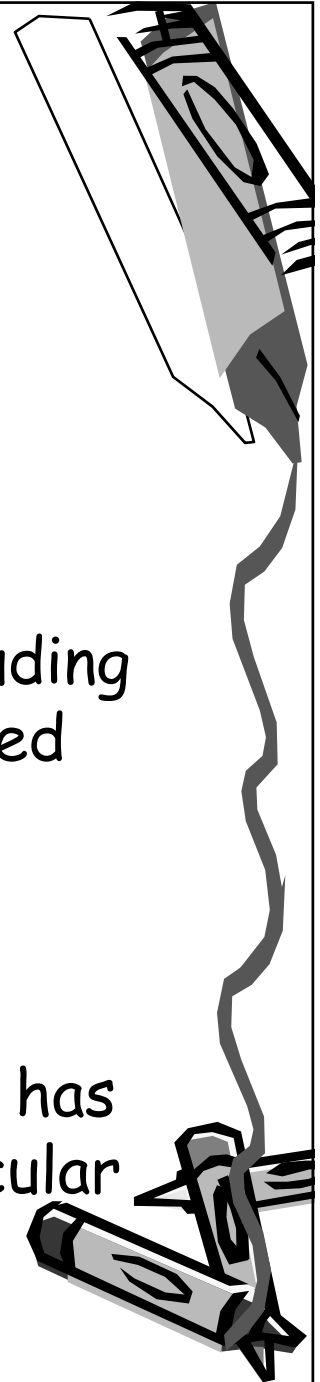
Req. 1105 Global verbosity

Requestor: LHCb (F. Ranjard), other?
Responsible: M Asai

- Provide a 'global' verbosity setting, which the user can use to request minimum verbosity from all verbose Geant4 components.
- New information
  - Key interest is to avoid printing during Initialisation
  - Want to keep information on difficulties, warning in event simulation
- Status
  - Under study.
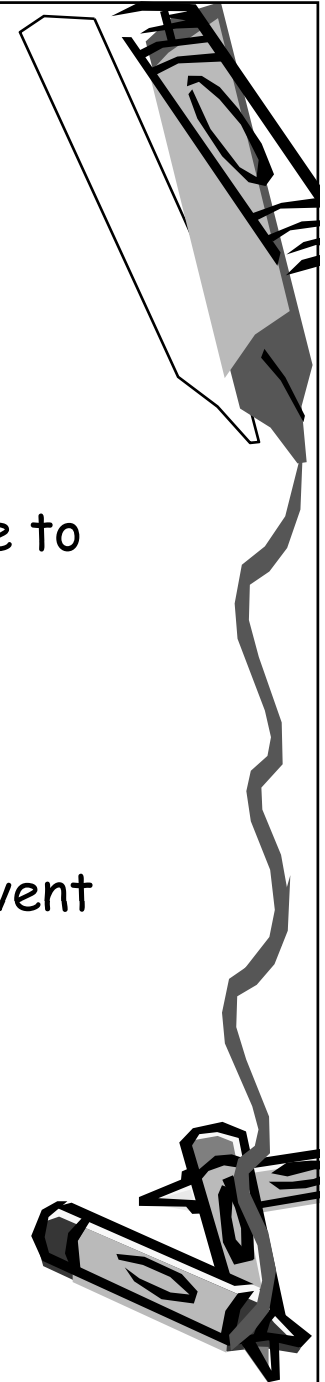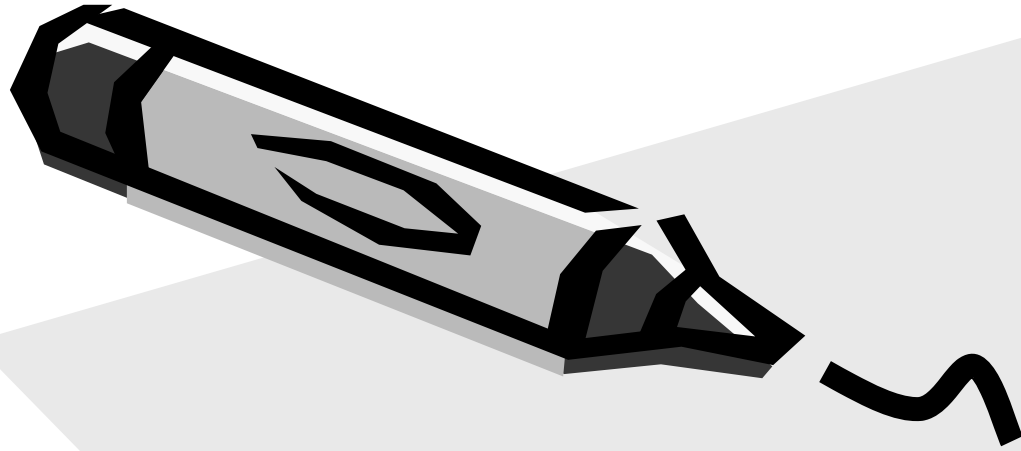
Longer term requirements

2. Requirements assigned "long-term" status before
end 2006
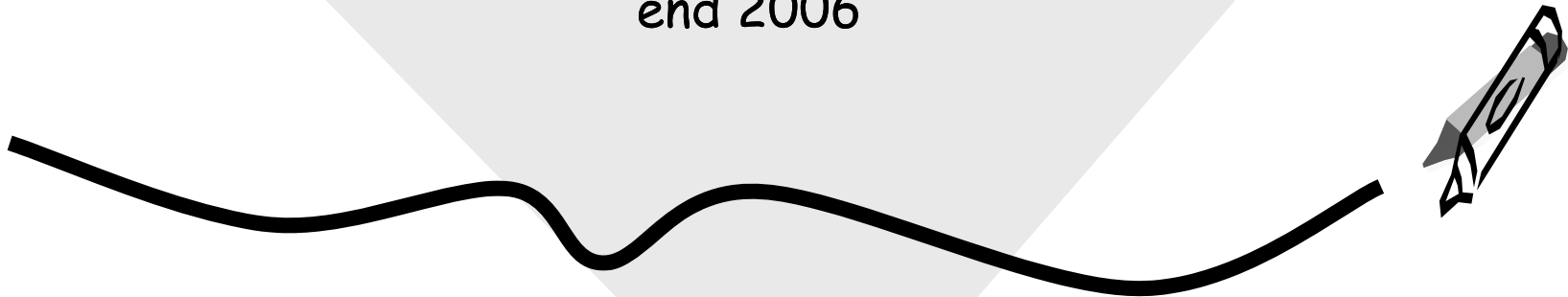
Req.1201: Improvements QGSP angular distributions

Responsible (new): G. Folger

Requestor: HARP (V. Ivantchenko)

Description: "HARP needs following improvements in the energy range of 1-15 GeV."

- QGS model improvement to provide a smooth inclusive theta distribution in forward direction < 1 degree

Status (July 2008): Resource limited

- Difficulty due to model applicability which starts around 15 GeV

  - Issue under investigation

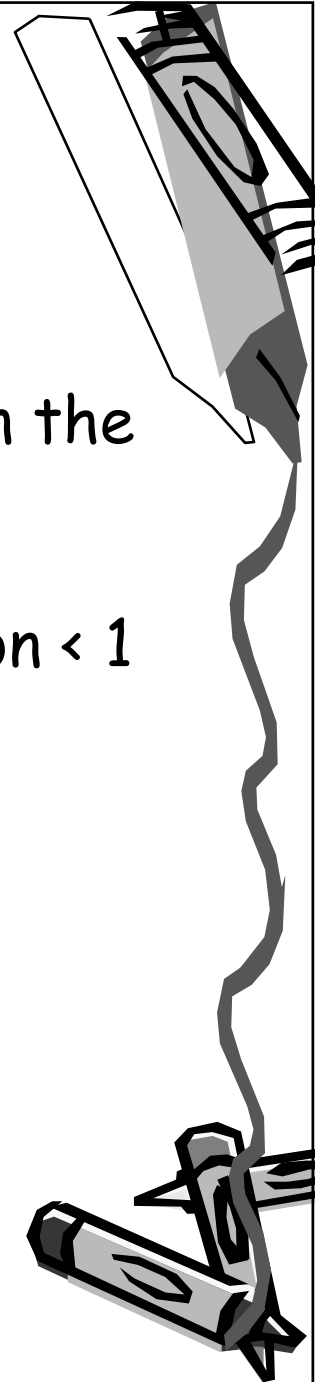# Req.0401: Extension of Ion hadronics interaction to cover a good part of the cosmic ray range in (A,Z) and energy

Responsible: D. Wright / T. Koi (new)
Requestor: ESA (G. Santin)
Status (mid-2005)
- EM dissociation: Released in G4 6.2
- Inelastic reactions
  - E < 10 GeV / A: Xsec (G4 6.0), model 4 light ions (<= C) in G4 6.1
  - For E > 10 GeV / A
    - Systematics [at O(1%) level] of σ prediction from QGSM.
    - Prototype extension of QGSM (lost?)
      - for final state generation in central rapidity for all ions, and projectile and target fragmentation based on exciton pre-equilibrium model.
  - Work to be done (ca 2005): radioactive decay for relativistic ions, EM dissociation for higher excitations than quadropole resonance.

Update (July 2008)
- New native-G4 Quantum Molecular Dynamics (QMD) model:
  - First release including reaction to ~500 MeV (TBC): 9.1 (Dec07)
  - extension to few GeV/c provided in 9.2 beta (June 2008)
- Interface to DPMJET II.5 under development (funded by ESA)
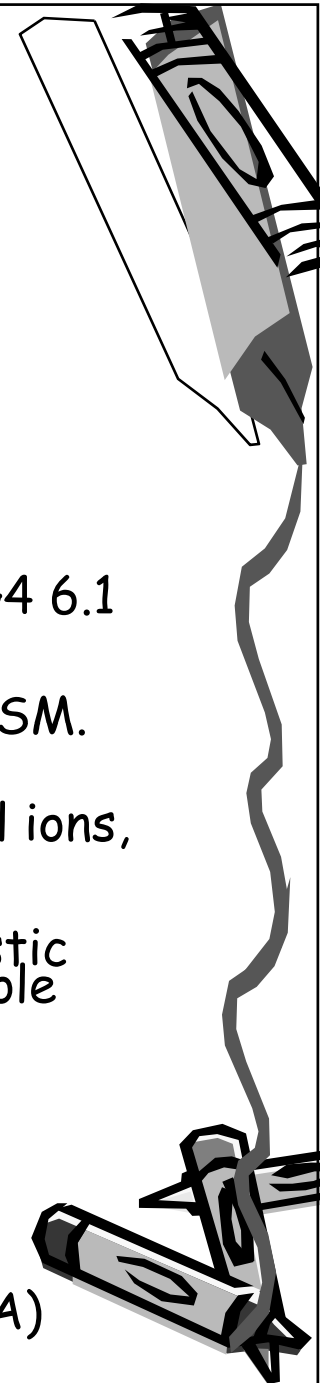
Req.0506: Optical photon transport in setups with repeated volumes

Responsible: P. Gumplinger
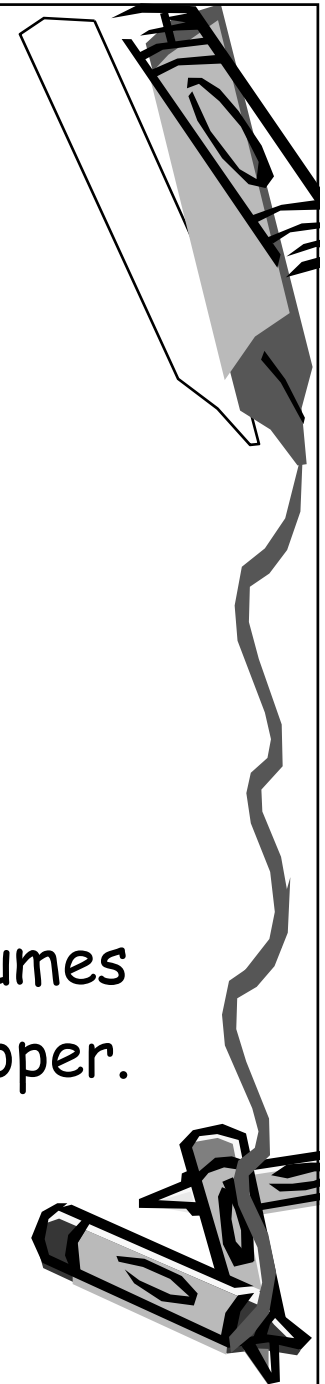
Requestor: TRIUMF (P. Gumplinger)

Date of request: Oct. 2004

Enable optical photon transport in setups with parameterized/replicated/divided volume

Status (July 2008): to be verified

We expect that it already works for replicated volumes

– Remains to be positively verified by the developer.

703. Treat particles with dipole moments

Originator: AD (Bertalan Juhasz)

Responsible: J. Apostolakis, H. Kurashige

- The user should be able to calculate the force acting on the magnetic (and possibly electric) dipole moment of a (neutral or charged) particle in an inhomogeneous magnetic (electric) field [F = mu * grad B]
  - for this, the magnetic dipole moment of a particle should be available for the equation of motion;
- Note: the magnetic moment is not always a vector of constant magnitude,
  - In magnitude and direction it can depend on e.g. the external magnetic field
- the force will be calculated by a user-derived equation of motion class (ok)

Comments/Status: Open

- First proposal for a working solution was communicated (Sept 2006)
- NEW (Dec 2006)
  - User created prototype implementation – improved after discussions
    - A first working solution now exists (but has toolkit modifications)
  - Further toolkit improvements planned, to enable better integration
- For a solution 'integrated' in the toolkit: second design study done (Dec 2006)
  - Particle properties for magnetic dipole moment (MDP) needed (planned)
  - Revised field-track to carry MDP (done, June 2006)
  - A revised or derived transportation (tdc)
    - Identify neutral particles with MDP (or EDP), and pass properties
  - A revised equation of motion is needed (user can do – missing only MDP info.)

1301 Fixing visualization of boolean solids

Requestor: CMS / Y. Osborne, F. Cossutti

Responsible: J. Perl

Context: G4 Boolean Processor fails to create G4 subtraction solid out of shapes sharing surfaces
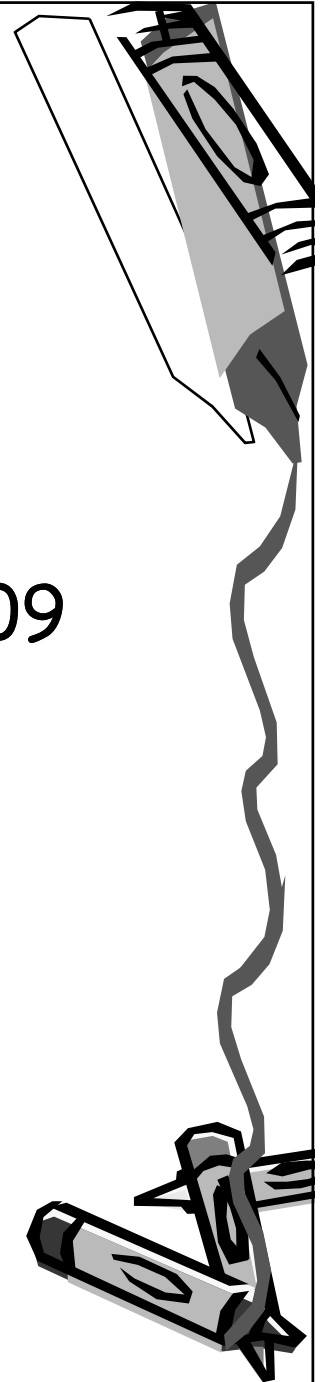
Status (July 2008): **Not resourced**

- Understood issues – corrections require major rewrite of functionality.
- Identified potential implementers. Funding to support this not yet found.
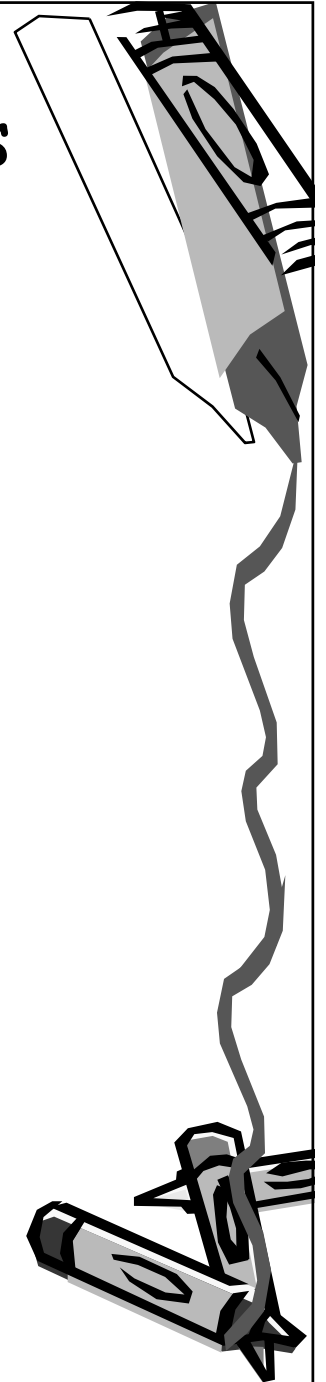
Longer term – and closed by March 2009

Longer term requirements

Closed March 2009

- As proposed in July 2008

Req.0601: More details in error messages

Responsible: J. Apostolakis, M. Asai, G. Cosmo
Requestor: LHCb (G. Corti), seconded by CMS

- To help in debugging problems in the production environment we wish to have detailed message when there is a problem. This already occurs for the hadronic physics and we have found it very useful. It would nice to have similar detailed message from the other parts of Geant4.

Additional Information:

Typical message from G4HadronicProcess is
"Unrecoverable error for:
  - Particle energy [GeV] = 2.452
  - Material = Aluminium ;
  - Particle type = proton
 EXCEPTION: Fatal Exception number 007 in G4HadronicProcess:
   GeneralPostStepDoIt() failed on element selection."

This enables easy reporting of problem, and enables developers to find it. It makes it simpler to identify the cause, and therefore faster to resolve it.

Analysis

Some key conditions that allow this verbosity in hadronics (few calls and small overhead in terms of CPU time) do not exist in other key components: geometry and EM physics.

Discussion: What key areas and types of additional information are of most interest ? How much of performance overhead is acceptable ?

Status (as of July 2008): **Ongoing** improvement of 'diagnostics' messages

Propose to **close** this item (July 2008)
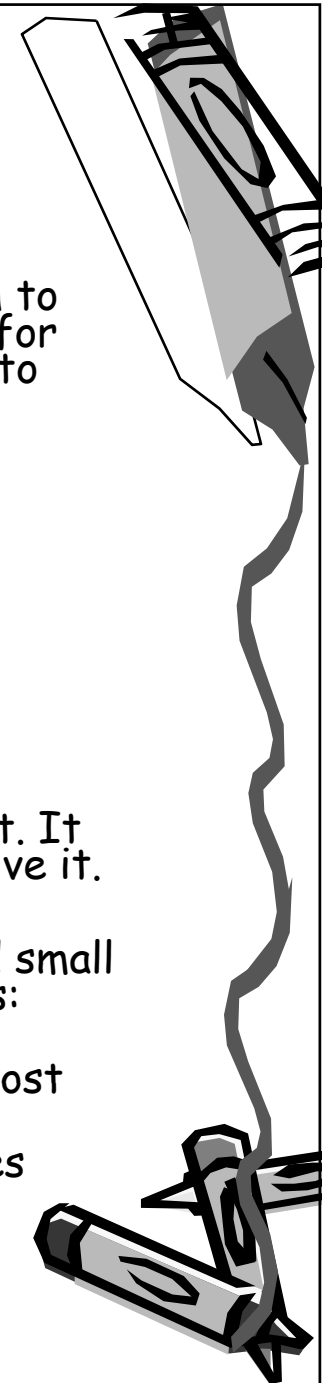
Req.0605: Adding touchable to secondaries

Responsibles: T. Sasaki and P. Gumplinger

- Touchable should be always attached for all secondaries.

Notes:

- Since 7.0, hadronic processes add a touchable handle to secondaries.
- Dec 2005: Found a few which do not assign a touchable (in case of position in current volume).
  - G4OpWLS (Optical process for wavelength shifting)
  - G4Cerenkov, G4Scintillation
  - Further study XrayTR radiation (issue regarding active volume)

Status (July 2008): Implementation completed

Propose to CLOSE

Questions for documenting behaviour and improving (2006)

- Are users affected by this behaviour ? Ans: To first order only due in CPU time
- Have we documented difference between
  - end-point (and along) secondaries which are in the same volume, and
  - secondaries that leave the volume (eg refracted, leaks in fast sim.) ?
- Potential improvement: Should tracking set the touchable (instead of process) for secondaries at end-point ? [G4 internal issue]
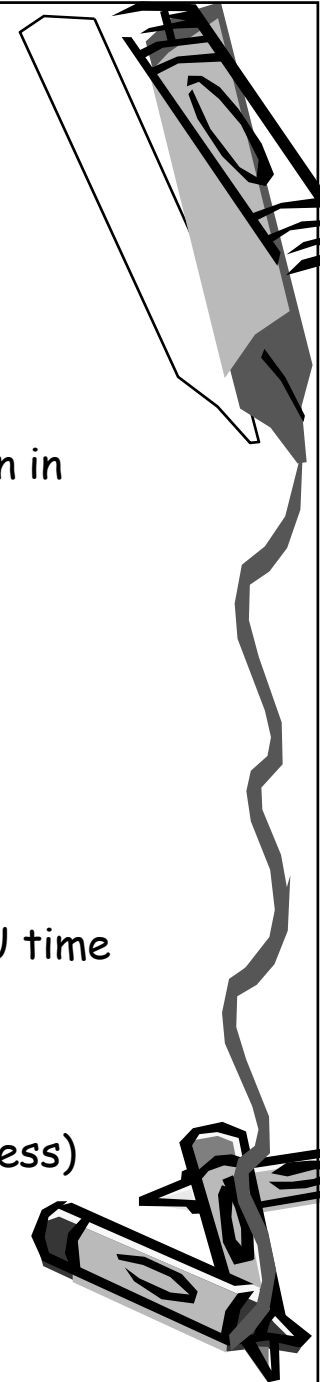
0304 Geometry construction
- input from external models via GDML

Responsible: G. Cosmo

Additional way to input the description of the geometry of a setup via GDML.

Old Status (2006)

An improved reader for GDML was provided in 2005.
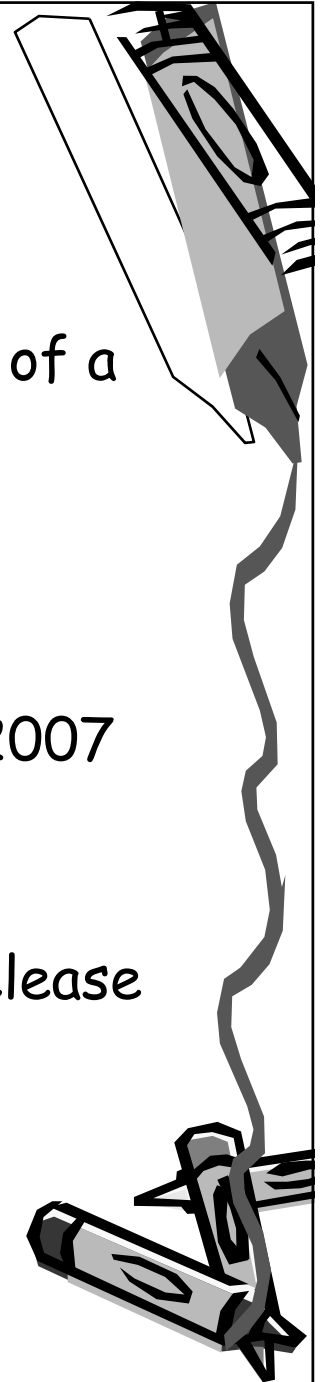
A first writer for GDML was created in 2006.

Ability to read tesselated solids (for CAD conversion): 2007

Status (July 2008): complete

Extensions and updates provided 2006-2007.

- A new reader, embedded in Geant4 was provided in release 9.1 (Dec 2008)

- A new writer included in Geant4 9.2 (Dec 08)

  - first provided in Geant4 9.2 beta (June 08)

Proposed to CLOSE this (Jul 08)

Closed

Req.0303: Performance of G4

Responsible: J. Apostolakis / G. Cosmo

Description: "Compared to G3 simulation, under similar circumstances G4 is reported by the LHC experiments, to be a factor 1.5-2 slower. A study group started last year to address this issue, and should continue with more priority. This is expected to be a collaboration between G4 and the users."

Status (2006)

- Simple setup benchmarking, part of release process
- Propose regular meetings to address this issue, and other continuing issues (eg identifying hard to find problems).

Status (July 2008)

- No head-to-head comparisons with Geant3 in 2+ years
  - Comparisons for same physics accuracy take effort!
- Note: Report of Performance team in July 2008 TF meeting
- Propose to CLOSE (July 2008)

Closed
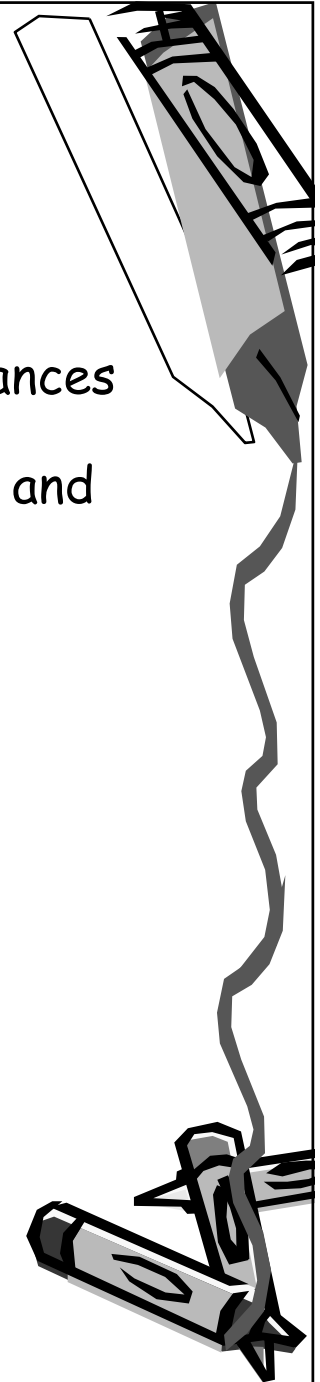
Req.0502: Treatment of particles that get stuck during simulation

Responsible: G. Cosmo, J. Apostolakis

Requestor: CMS, LHCb

Description: "CMS drops a track if it is stuck and continues the event. G4 by default abandons the event. Neither is good."

Status (ca. 2006)

- Since Geant4 7.0 a stuck track is given additional kicks and chances to continue
    - only most problematic 'stuck' track is killed.
- Related requirement for tracking in field is Req.602
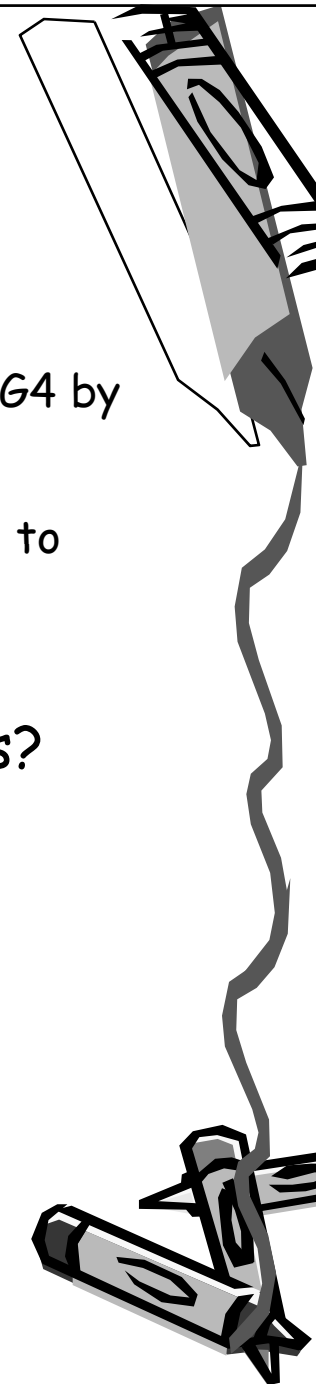
Q: What is acceptable behaviour for truly stuck tracks?
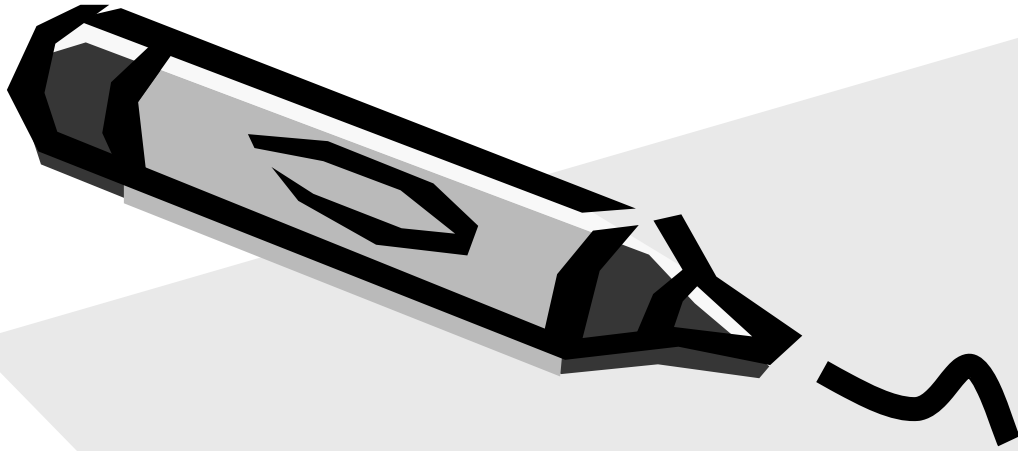
Update (July 2008):

Improvements in diagnostics:

- Check whether a problem due to an overlap? (9.1)

- Future:

    - Additional printout to aid debugging underlying problems planned for 9.2 (Dec 2008)

Propose to **close** (July 2008)
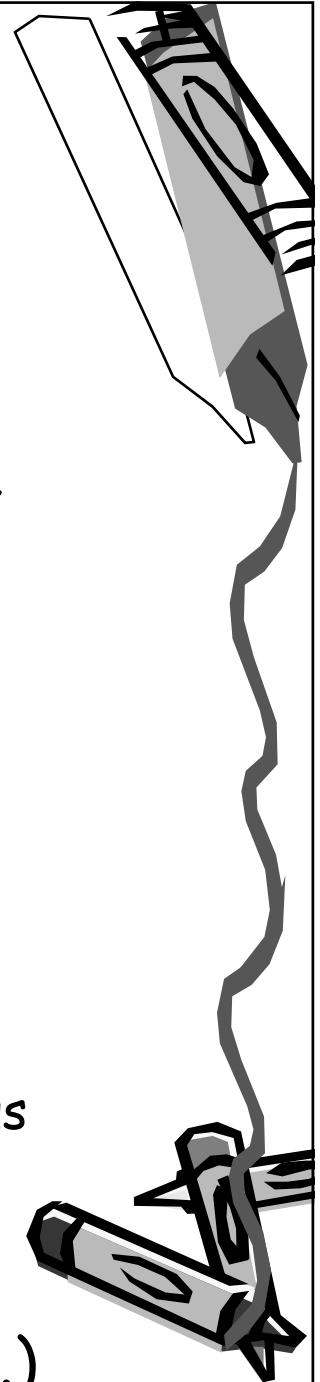
Closed

Closed by July 2008

1604: Performance improvement

Requester: CMS (J. Yarba)

Responsible: J. Apostolakis

- Address hotspots found in profiling studies (FNAL, CERN)
- Several software experts looked at the Geant4 performance aspects, starting from CMS application
  - Mark Fishler (Fermilab)
  - Jim Kowalkowski (Fermilab)
  - Marc Parerno (Fermilab)
- Status
  - Specific issues raised in late 2006, spring 2007
    - Converting between PDG code and internal code
      - LHEP, CHIPS
    - Taken up by performance team
- Feb 08: Propose to close this item - this process is continuous
- July 08: Closed

Requests / requirements Nov 2006 (cont.)
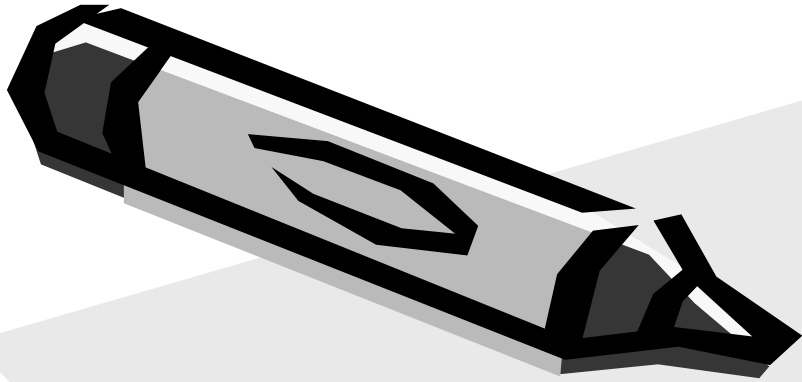
Requirements closed/replaced
by Nov 2007 meeting

Req.0103 part 2: Geometry construction - input from external models: b) CAD

Responsible: G. Cosmo

Read a geometry setup from a file generated by a **CAD**-program.

Status of CAD interface:

- Since release 8.0 it is possible to import CAD STEP file using an outside tool to approximate its shapes into tessellated solids.
- This way a user can import single shapes or 'full' geometrical setups (at least of small/medium complexity),
    - Start: file of geometry description produced by CAD application
        - Typically the file is STEP compliant[†],
- Two steps that use additional software are needed:
    - a satellite application converts all solids to tessellated solids
        - STViewer is a commercial view (cost ~ $300)
        - A free view module is available since October 2007 from a company as part of the package FASTRAD from 'TRAD'
            - » Potentially keep simple shapes as CSG solids (tbc)
            - » It is free, as this development was sponsored by ESA
            - » It has an additional for-pay module* with added abilities (see slide notes)
- The output is GDML file descriptions, which can be read by Geant4 GDML reader.
- Propose to close this requirement (Dec 2007); Closed Feb 2008.

Footnotes: †some tools could read other formats too. * For clarification see slide notes.
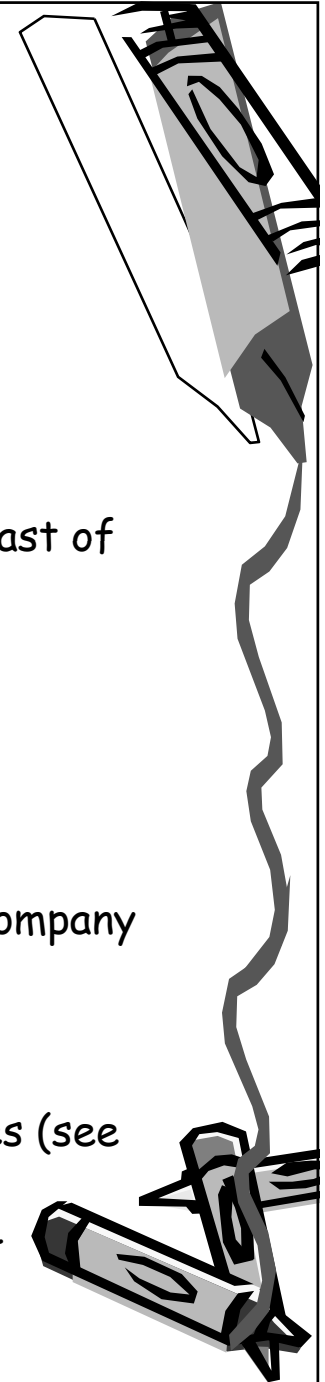
1605 - Address numerical instabilities
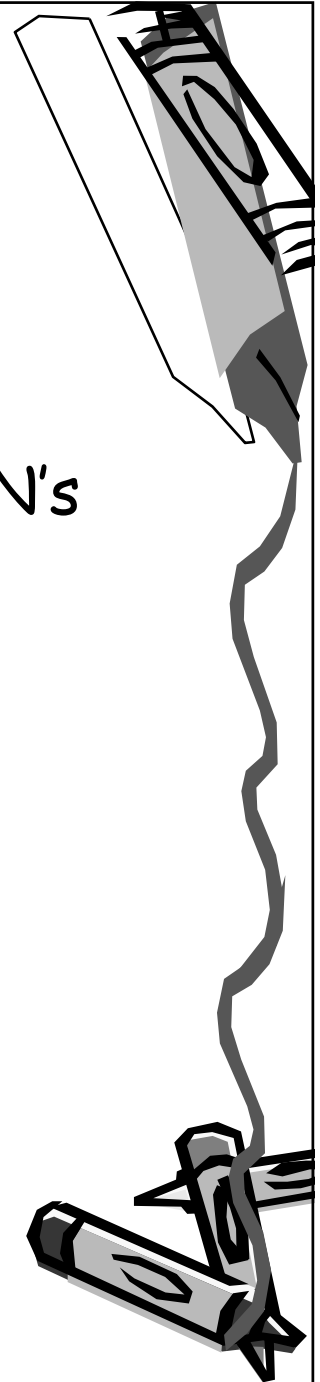
Requestor: J. Yarba (CMS) – Nov 2006

Responsibles: various

- A number of classes were found that create NaN's

Status:

- All causes of NaN were addressed in release 8.2 (Dec 2006).
- Propose to close

Closed

Req 1203: Document which particle properties can be changed

Responsible: H. Kurashige

Requestors: Atlas, LHCb (followup from reading particle properties)

Context: The capability is now enabled to change particle properties. Need guidelines on what changes can be made for which particles, without impacting Geant4 internal consistency and results.

Current assessment / proposal on priorities

- Open to change properties of heavy particles, for which there are no physics processes in Geant4 (and so expect no impact)
  - B, C, T meson/baryon, W/Z bosons,..
- For mesons/baryons
  - Properties of resonance must be maintained.
    - in particular need stability for Δ, N*
  - some changes are safe for light stable particles (pion, Kaon)
    - But impact to be studied
- For light leptons (e, μ), there is little forseable benefit to changing properties
  - And potential impact to check effects if masses are modified

Request feedback on this proposal (April 2006). If it adequate for now, propose to close this requirement, copying this to appropriate docs.

Closed

Requirements closed/replaced at July 2007 meeting
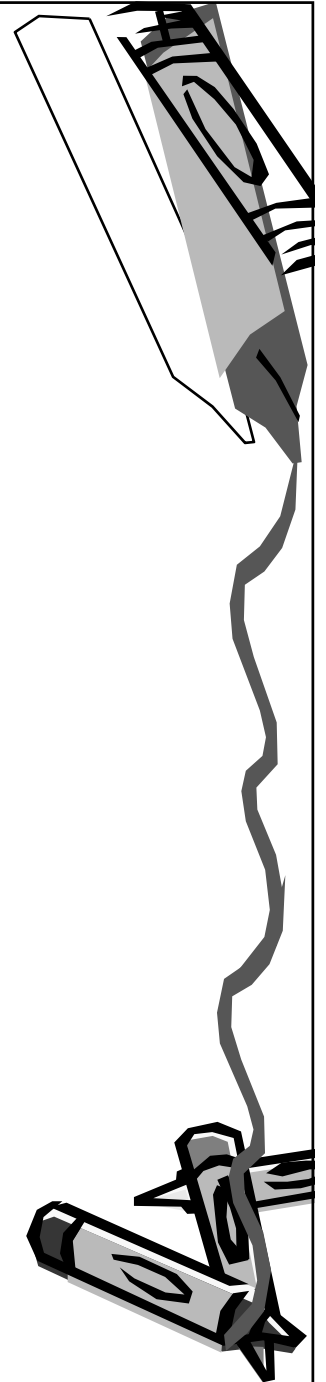
1601: Further refinements for TGeo Interface

Requestor: Andreas Morsch for ALICE

Responsible: G. Cosmo

- the modification needed to interface Geant4 with TGeo as a geometry modeler. The details have been already communicated by Andrei Gheata

Status

- Delivered in Geant4 8.2 (Dec 2006)
- Propose to close

Closed

Requests / requirements Nov 2006 (cont.)
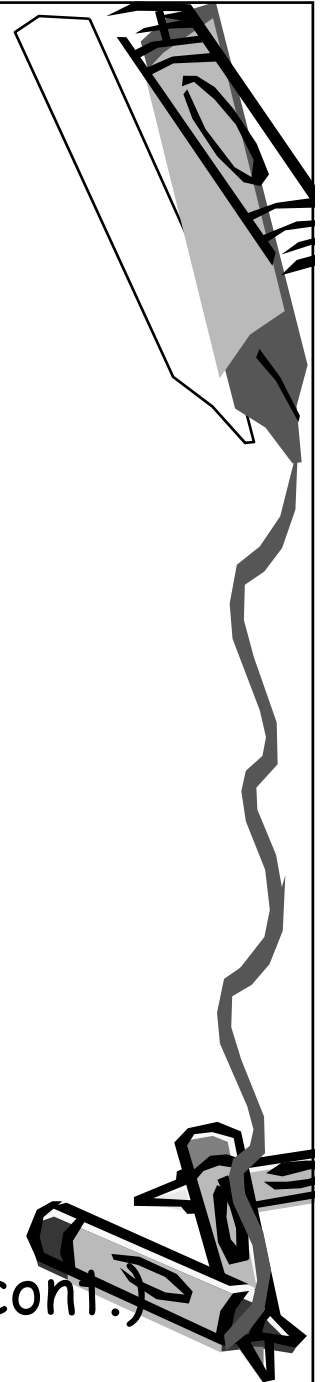
1603: Build system for physics lists

Requestor: CMS (M. Stavrianakou)

- Allow build of granular shared libraries
- Allow automatic installation in standard library directory

Status:

- Physics lists incorporated into source directory (Geant4 8.2)
- Believe this addresses the issues.
- Propose to close this issue

Closed

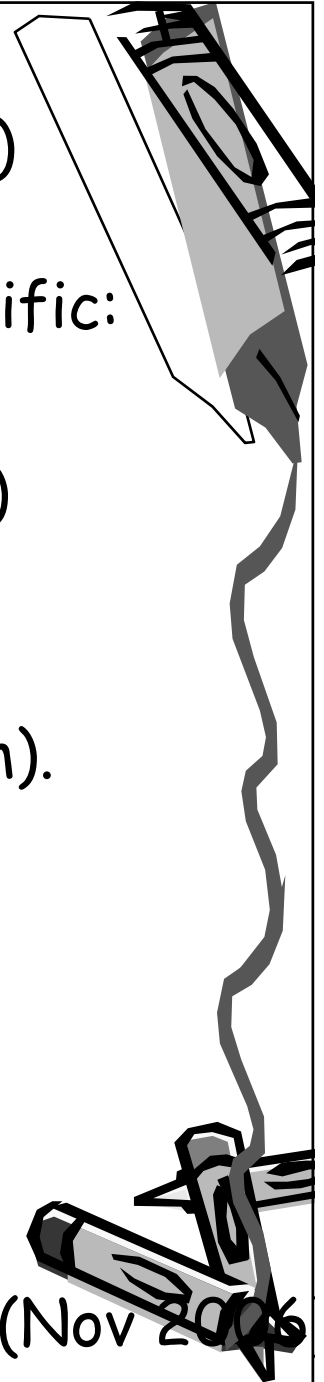Requests / requirements Nov 2006 (cont.)

Further – from Space Users meeting (Nov 2006)

Additional, currently not sufficiently clear or specific:

- Add more isotopes to G4NDL.
  - Requester Scott Messenger (SFA Inc & NRL)
- More documentation, everywhere (no specifics mentioned)
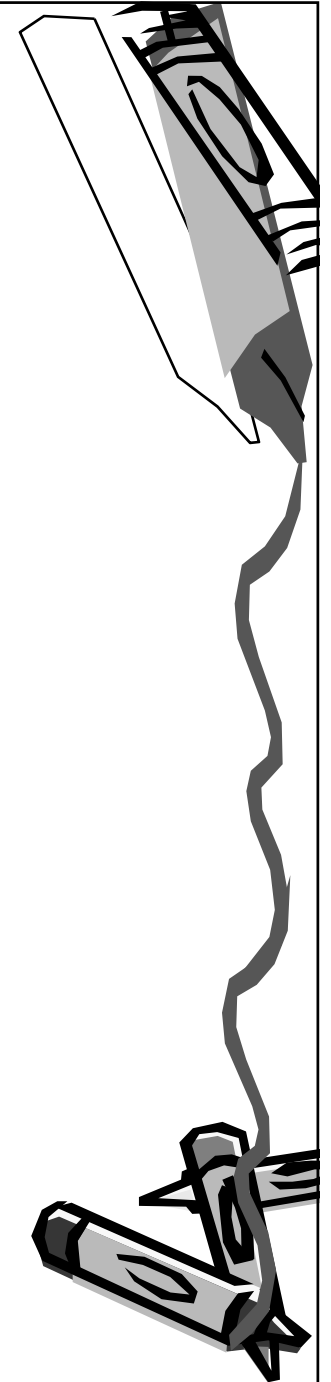 - Requester Bart Quaghebeur (BIRA in Belgium).

From Space Users meeting (Nov 2006)
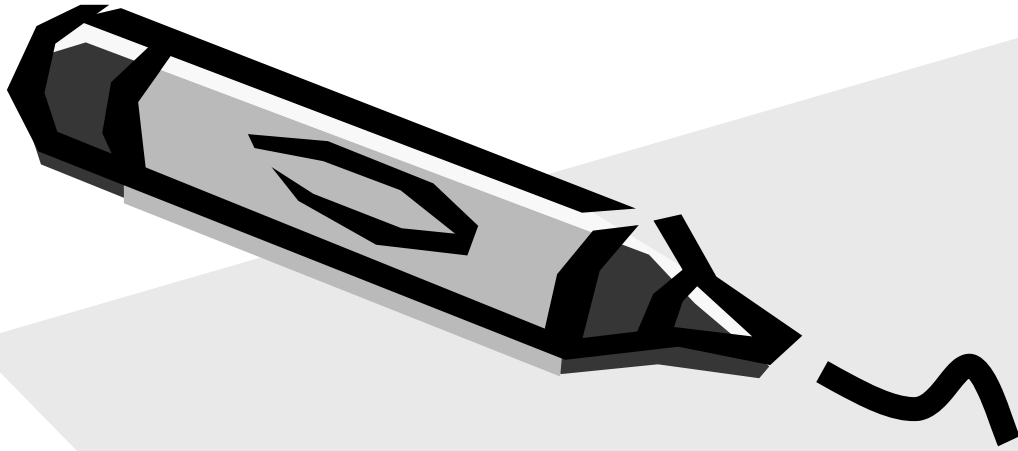
Other requests/requirements of 21 Nov 2006

Requests from CMS

- Visualization of boolean solids - Y. Osborne
  - Already tracked (1301)
- Address numerical instabilities – J. Yarba
  - Address issues that create(d) NaN's
    - Got assigned number 1605

Requirements closed/replaced
after Jan/Mar 2007 meetings

# Req.0603: Option not to suspend tracks

Requirement from BaBar (D. Wright)

Responsibles : D.Wright /A. Heikkinen (hadronics)

- Currently few processes which suspend particles.
- For BaBar applications, it would be very useful not to suspend the particle (at least in the hadronic processes).
- Details:
  - Processes involved are G4Cerenkov, G4Scintillation, G4FastSimulationManagerProcess, G4HadronicProcess
    - For G4HadronicProcess, only one hadronic model (G4NeutronHPElastic) invokes the suspension.

Discussion: An option adding a switch to a suspending process that enables the user to turn off/on the suspension of the particle could be a solution.

Status/Update:

- Optical and Fast Simulation processes had switches.
- Released in v8.1 :
  - Created option to turn off neutron suspension in HPElastic models: added method DoNotSuspend() to G4NeutronHPElastic and G4NeutronHPorLElastic.
- So this is satisfied
- We propose to close this request Nov 2006.

Closed
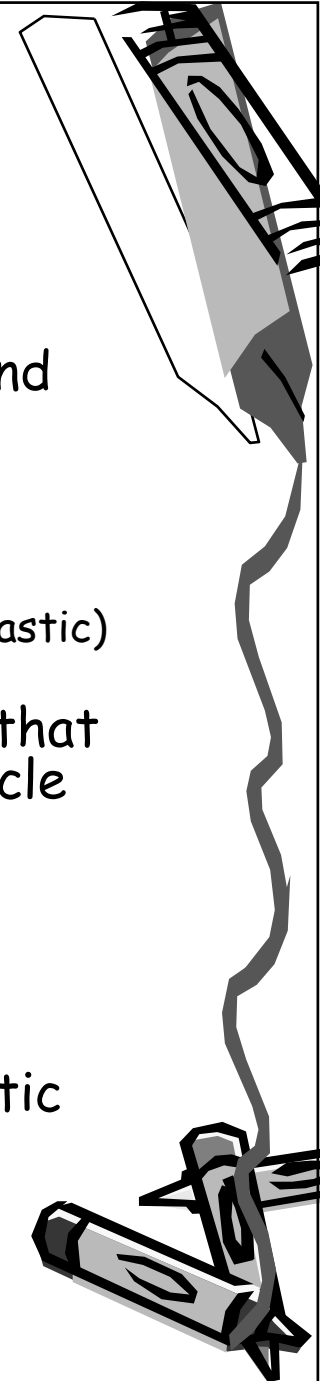
Req.0604: Nested parameterizations

Originator: M. Asai (on behalf of medical users)

Responsible: J. Apostolakis

Access to a touchable from "Compute" methods in
   G4VPVParameterisation class

 - Position, material, etc., could be parameterized with copy numbers
   of parent volumes (mother/ancestor) in addition to its own.

Status:

 Delivered G4 release 8.0

- Interface enables use of 'parent' touchable providing access to
   full volume tree information

- Parameterization must specify materials (new methods)

   – Corrected problem in accounting for these material in region
      scanning. Fix is included in Geant4 release 8.1

- Requirement SATISFIED.

- Proposed to close this completed requirement (Nov 2006)

Closed
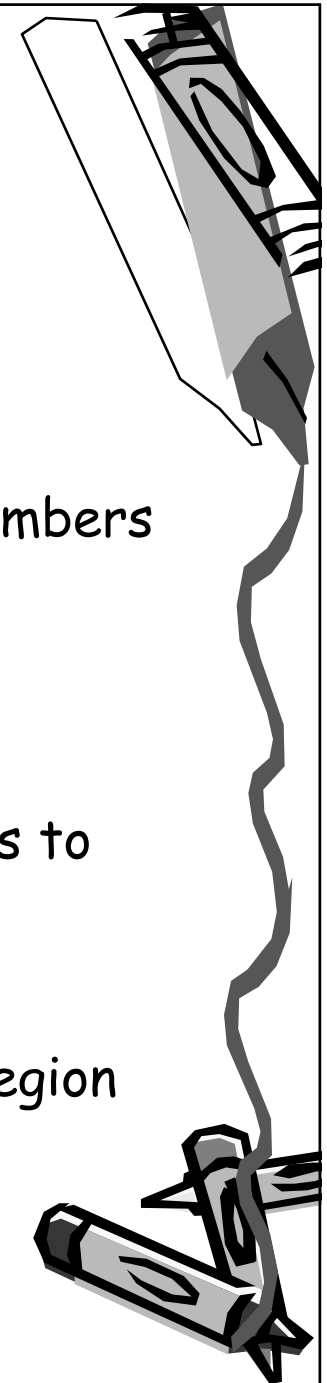
Req 1101: Secondaries created this step

Requestors: Atlas, CMS, LHCb (W. Pokorski)
Responsible: M. Asai / T. Sasaki

For processing of "truth" information, Geant4 needs to provide
- the number of secondary tracks created in the current step
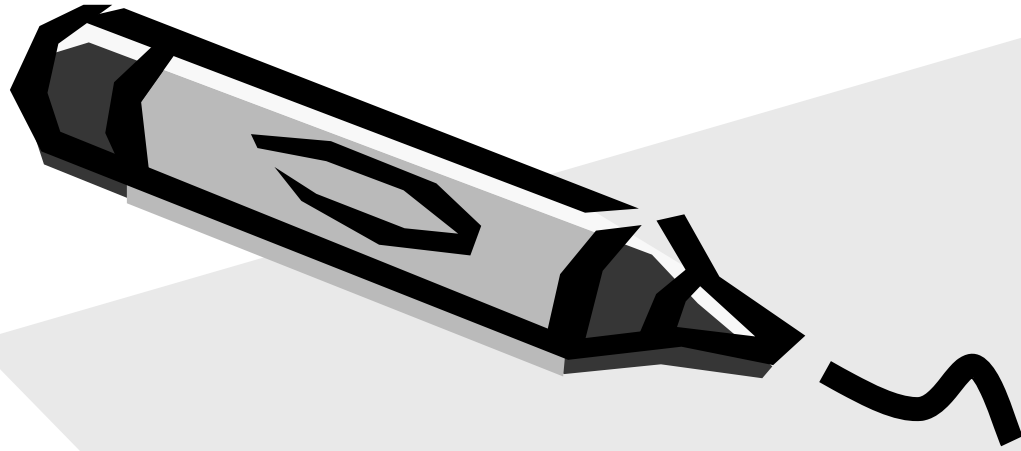- a way to access these secondaries

Update:

With 8.2 release, G4Step has a vector of secondaries generated in the particular step
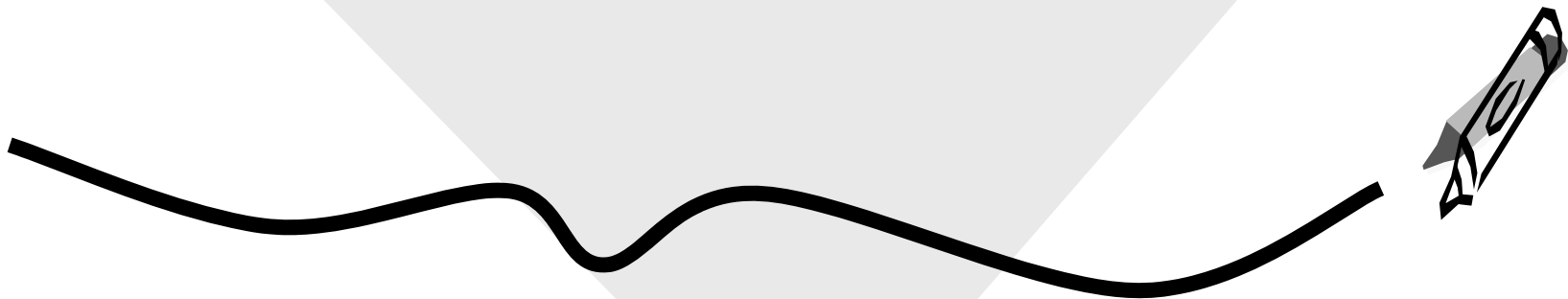- This vector is unprotected, but do not modify it!
  - Reason is that it is also used by G4TrackingManager, …
  - Users must not to modify the contents
    - the stacking action is available to decide which are tracked, their priority, …
  - We may revise this implementation in the future, in order to protect the vector.
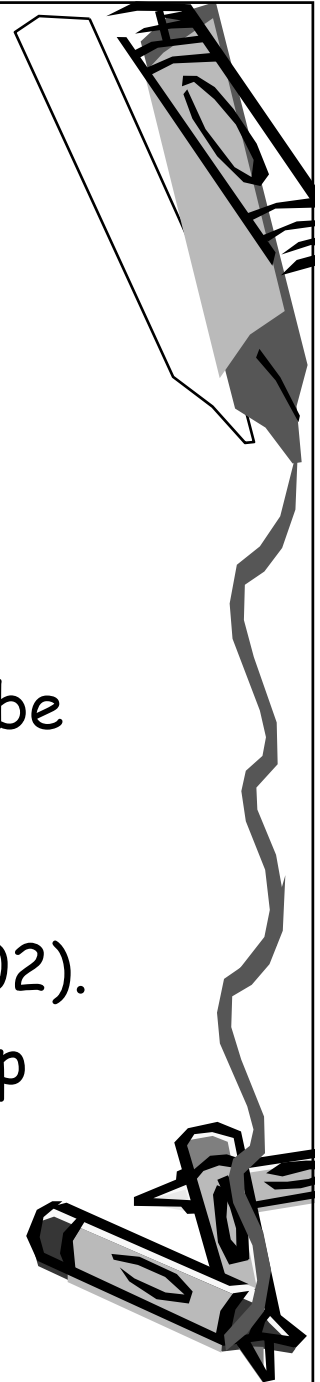
We propose to close this request (Nov 2006).
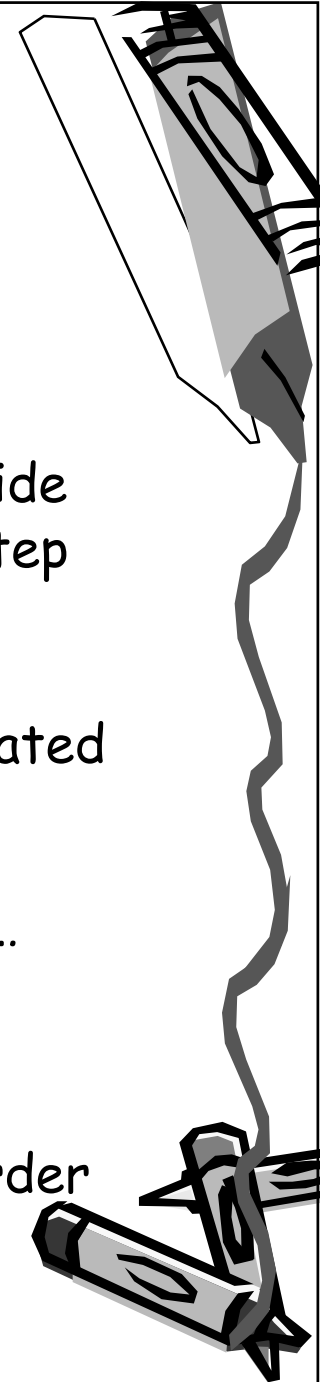
Requirements closed/replaced
after Nov 2006 meeting

Recently closed

- Req.0313: Particle properties from an external source (LHC)
- Req.0403: Unique set of physics lists (ESA - G. Santin)
  - Unify physics lists, EM and hadronic
- Req.0501: Print-out of created processes should be optional (LHCb, Atlas)
- Req.0505: Improvements in hadronics (HARP)
  - Remaining sub-items have been split (1201, 1202).
- Req.0602: Protect high energy particles from loop killing (CMS)
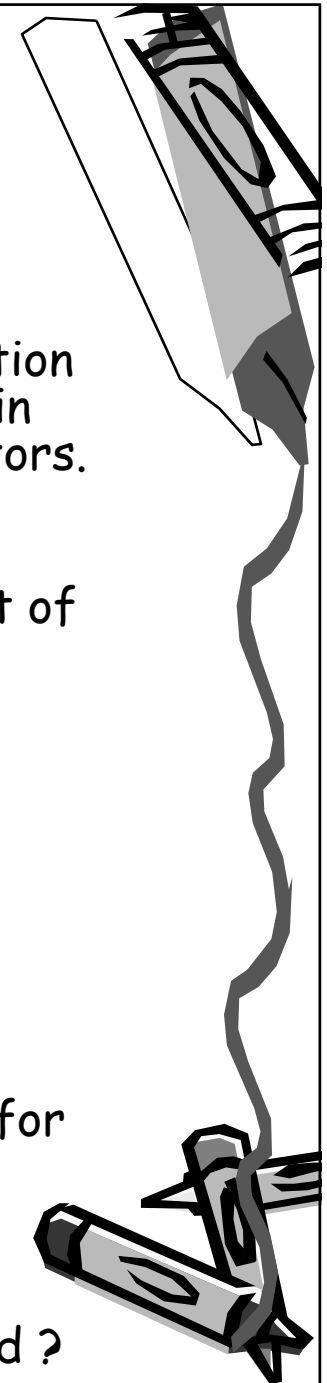
Closed

# Req.0313: Particle properties from an external source

Responsible: M. Asai, H. Kurashige

Requestor: LHC

Description: "Request to study whether one can have a unique definition of the particle properties throughout all the physics models within G4 and preferably also consistent with the values used in generators. A candidate catalogue can be HepPDT, extracted from the PDG tables."

- Design study, implementation, performance tests, and assessment of effects on user code achieved 1H2005.
  - Refinements and resulting changes in G4 source, 2H2005.
- Latest (Nov 2005)
  - Developments scheduled for inclusion in Geant4 ver 8.0.
    - "non-static" particle definition
    - revised hadronic physics lists.
- Restriction: Use for resonances is not foreseen now – would need studying
  - some physics models require particular values of mass/width for particular resonances (in general poorly measured).
- Note: gcc 2.95.X is not supported.
- Req. 1203 follows up the documentation issue.
- A concrete example/implementation was discussed – is one needed ?
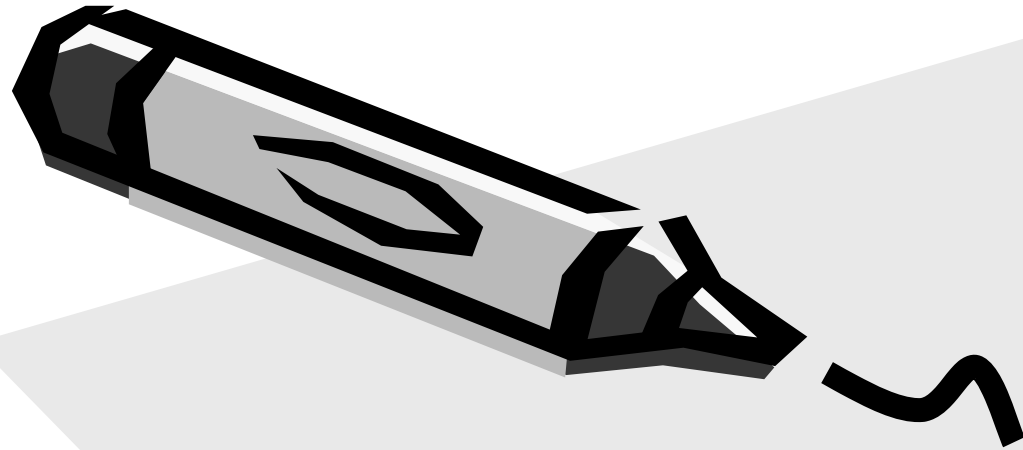
Closed

Requirements closed/replaced in
April 2006 (Geant4 8.0 or 8.1)

Req.0403: Unique set of physics lists

Responsibles: V. Ivantchenko / G. Folger / M.G. Pia

Requestor: ESA (G. Santin)

Description: "Unique set of physics lists (by use-case) and not two sets as now, one for EM and one for hadronics."

Latest

Physics lists (for hadronic use cases) in release Geant4 8.0 use the EM physics builder from EM(std).

Propose to <u>close this</u> – and create new requirement, if needed, for remaining issues with updated, precise information.

Closed

Req.0501: Print-out of created processes should be optional

Responsible: M. Maire / M.G. Pia

Requestor: LHCb, Atlas

Description: "The list of created processes is printed out at the beginning. Though it is useful for development and verification, it should be possible to switch-off for mass production run."

Status:

- Option in EM(std) verbose level -1 stops print-out.
- Identified need for 'PreInit' actions to trigger this
  - LHCb has agreed to try this soon.

Closed, as it confirmed OK by LHCb.

Closed
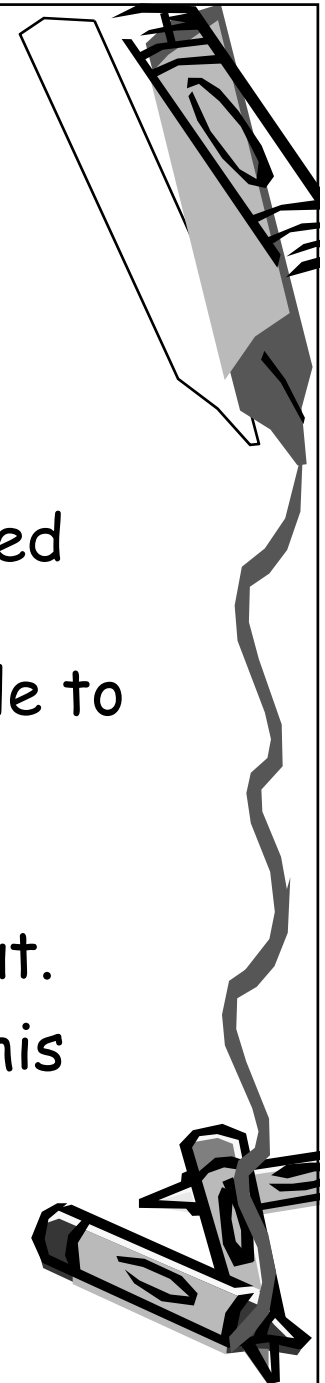
Req.0505: Improvements in hadronics

Responsible (new): D.Wright /A. Heikkinen (hadronics)
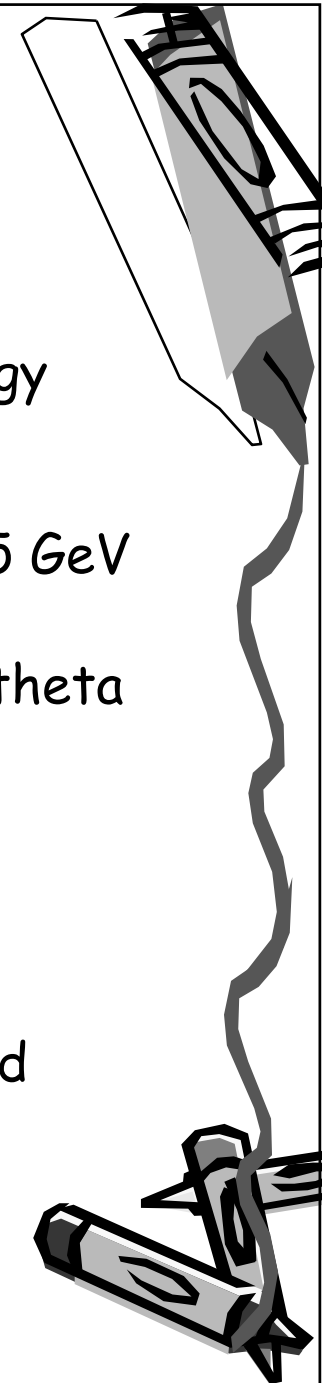
Requestor: HARP

Description: "HARP needs following improvements in the energy range of 1-15 GeV."

- – Bertini Cascade robustness for production - OK
- – Binary Cascade extension to pion incident – Done to 1.5 GeV
- – CHIPS be available as alternative
- – QGS model improvement to provide a smooth inclusive theta distribution in forward direction < 1 degree

Status

- • G4 6.2 patch 2 included fix for a Bertini problem.
- • Pion projectiles for Binary Cascade enabled in 6.0
  - – Approach limited up to 1.5 GeV due to resonance data
- • Improvements to QGS model theta distributions in forward direction (< 1 degree) underway.

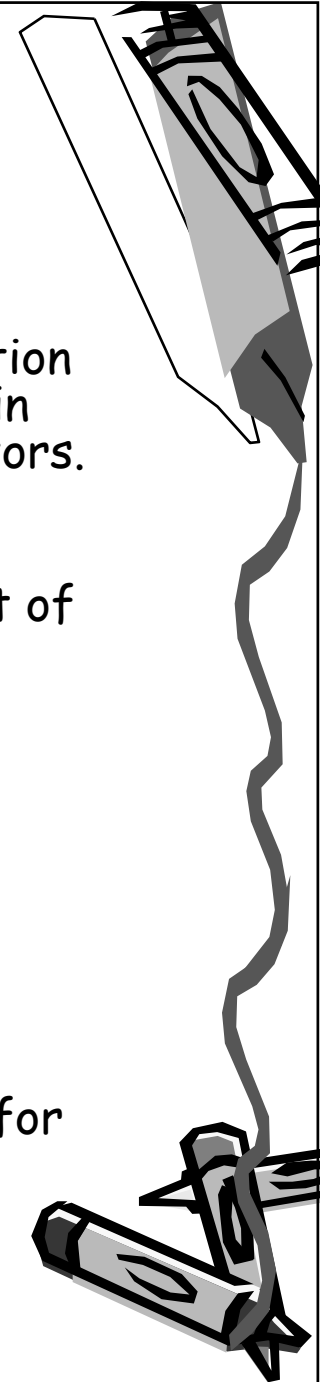Creating new single-issue requirement for different parts.

Req.0313: Particle properties from an external source

Responsible: M. Asai, H. Kurashige

Requestor: LHC

Description: "Request to study whether one can have a unique definition of the particle properties throughout all the physics models within G4 and preferably also consistent with the values used in generators. A candidate catalogue can be HepPDT, extracted from the PDG tables."

- Design study, implementation, performance tests, and assessment of effects on user code achieved 1H2005.
  - Refinements and resulting changes in G4 source, 2H2005.
- Latest (Nov 2005)
  - Developments scheduled for inclusion in Geant4 ver 8.0.
    - "non-static" particle definition
    - revised hadronics physics lists.
- Restriction: Use for resonances is not foreseen now – would need studying
  - some physics models require particular values of mass/width for particular resonances (in general poorly measured).
- Note: gcc 2.95.X is not supported.
- Req. 1203 follows up the documentation issue.

Req.0602: Protect high energy particles from loop killing

Originator: CMS: (P. Arce) Old title: Tracks killed by G4Transportation

Responsible: J. Apostolakis

- G4Transportation kills a particle if during an step in magnetic field it has looped more than 1000 times without finding the boundary
  - In CMS min-bias events in CMS saw this 587.1 times **per event**
    - Average energy lost is ~1 GeV / event
- Some tracks have E > 1 GeV (in 7K events highest was 13.7 GeV)

Updated status:

- Protection avoiding to kill particles above 100 MeV (unless stuck 10 times) added to Geant4 7.0
  - CMS now sees ~0.5 tracks killed per min-bias event (7.1p01, Nov05),
    - When using cuts for particles at around 100 MeV < E < 250 MeV
    - Report also seeing same number with G4 6.2 for these conditions.
- Resolution of underlying issues needs further joint study.
  - What are the key characteristic of killed tracks?

Closed